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TROPICAL GEOLOGY AND ENGINEERING [1]

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INTRODUCTION

The purpose of the present paper is to discuss, first, the general geologic processes as they are found at work in the Tropics, contrasting their effects with the same processes in the temperate regions of the earth; and second, to cite some examples showing their practical bearing upon the engineering problems that arise in those regions.

From many years of contact with engineers and their problems, particularly in the case of tropical countries, the writer knows that often all too little attention is paid by the engineer to the fundamental considerations upon which geology alone

[1] Several years ago the writer published some notes in the Mining and Scientific Press of California. The present article is a completely rewritten, revised, and considerably enlarged discussion along the same lines.

is capable of throwing light. This is due frequently to a deficiency in and lack of breadth of training. How is it to be overcome? It is hardly to be expected that the engineer-student will be able to include more geology in his already crowded courses. That, however, is not necessary, for all that is desired is that he realize his limitations and the importance of the bearing of geology upon his work and the need for expert advice. Some engineers in the Philippines with whom the writer has had the pleasure of working showed that they appreciated this fully. Others did not, and as a consequence they have left monuments to their lack of insight.

Previous to our experience in the Philippines, Cuba, and Panama, Americans had had no extensive contact with the Tropics and consequently many of our engineering data were found untrustworthy when applied to wholly new and unusual conditions. An especially good example may be cited in the location of our highways and railroads. In the United States we run a railroad line up one cañon, over the pass, and down the other side by way of another cañon. This has been tried in the Philippines, notably in the Benguet Road; the result is that this road may have to be abandoned because of excessive cost of maintenance. In the Tropics, during high water, there is room for but one thing in a valley and that is the stream which occupies it; such a feat of engineering as that which has made the Royal Gorge and the Denver & Rio Grande Railroad famous is absolutely out of the question in the Tropics.

There is one cardinal rule to be laid down at the outset, namely, take nothing for granted; investigate each problem separately. Handbooks and set formulæ are worse than useless; they are dangerous.

GEOLOGICAL AGENTS

The three most important geological agents are diastrophism, vulcanism, and gradation. The last has four important contributing factors to be considered; namely, *a*, weathering; *b*, transportation; *c*, corrasion; and *d*, corrosion.

Diastrophism.—The first of these, diastrophism, denotes the up-and-down movements in the outer shell of the earth. Such movements are negligible apparently in the older and more stable parts of the earth, but even there they occasionally manifest themselves as earthquakes. In the newer parts of the earth, and particularly along continental borders, they are of considerable magnitude and importance. As it happens, many of these places are in the Tropics. This is true of both Panama

and the Philippines. Once before, and perhaps twice, the barrier of the Isthmus of Panama, which has cost so much in life, labor, and money to cut through, has been opened so that the waters of the Atlantic and the Pacific intermingled, and it is not at all impossible that future diastrophism will render all our labor useless. However, these movements are so slow as to be almost negligible in any one generation. Only the geodesist finds that he has to readjust some of his calculations. We see the results in many parts of the world of such movements, but as yet we do not know much about them. Our data are not sufficient. Two facts are established, however; namely, that such movements as have taken place in the Philippines have been great during the late geological periods, amounting to as much as 1,800 meters, and that they have been differential. There has been within the Recent period a marked tilting of the Philippine block toward the Pacific Ocean. This will explain to the engineer why we have comparatively shallow river mouths on the west side of the Archipelago, and deep, drowned ones on the eastern side. It should be stated that in some parts of the Archipelago, notably Cebu, the reverse is the case, which further substantiates the statement.

Vulcanism.—As the Philippine Archipelago is a part of the so-called "Circle of Fire" that girts the Pacific Ocean, we naturally expect vulcanism to be of such magnitude that engineers would be continually anxious. Nevertheless, except for those regions in the immediate vicinity of active volcanoes, little damage has ever been recorded from this cause. The most-marked effects were those noted in 1911 resulting from the explosive eruption of Taal Volcano, situated about 45 kilometers due south of Manila. Had there been a large city (the size of Kingston, Jamaica, for example) situated on the shores of Lake Bombon, tremendously greater loss of life and damage might have occurred. The town of Taal, a few kilometers distant, suffered to the extent that an old church made of volcanic tuff was badly disfigured and a triangular section of land, crossed by one of the Government's new highways, dropped about a meter, allowing the tide to come inland for perhaps four-fifths of a kilometer. The length of damaged road amounted to about 3 kilometers. These effects were due directly to earthquakes and indirectly to the volcano. Although four hundred ninety-eight distinct shocks were recorded in Manila at the time of the eruption, practically no damage there was noted. The claims of a certain American

firm dealing in a patent type of concrete construction, that none of its buildings had suffered any damage at the time, were strictly correct, for no buildings in Manila were damaged!

Another instance in which vulcanism did play an important part was that in which a section of road in Albay Province, Luzon, was obliterated for a distance of 3 to 5 kilometers by a fall of bombs and a deluge of mud and ashes from Mayon Volcano in 1915. As volcanic activity in the Recent period in the Philippines has been entirely of the explosive type in which no lava outpourings occurred comparable to those from the Hawaiian volcanoes, the damage resulting to public works would be of very different character and also less serious.

Gradation.—This is the sum total of the wearing-down process, in many respects the dominant type of geological work. If we analyze this process we find that the following agents are contributory: *a*, weathering; *b*, transportation; *c*, corrosion; *d*, corrasion. I would, however, make "corrosion" a subheading under weathering, there being two factors involved; namely, a mechanical deformation and a chemical change, either of which may precede the other. Once weathering, or to use a very crude term defining it in part only, "slacking," has taken place, transportation comes in and does its work; and then "corrasion," or mechanical wear, becomes operative, but not until there is movement.

Of course, these factors are operative in all countries and under nearly all conditions, but gradation proceeds at a maximum rate in the Tropics. Two reasons are given for this; namely, rainfall and temperature or, in a word, climate.

In the Philippines we have a mean annual rainfall of well over 2,540 millimeters (100 inches), with sometimes exceptional and almost unprecedented precipitation, notably 1,168.1 millimeters (46 inches) in twenty-four hours on July 29, 1911, at the Baguio Observatory. This is, as far as we know, the world's record for a single rainfall. The reported rainfall of 23,387 millimeters (905 inches) a year at Cherraponji, in Assam, has lately been questioned. However, a precipitation of over 15,240 millimeters (600 inches) has been recorded on Mount Waialeale, Kauai Island, H. T. At such times the streams leave their banks and spread out over the country in sheets of water. Needless to say, the amount of material then transported is almost unbelievable. Furthermore, we have another factor to consider, and that is velocity. Often this is not taken into consideration. When we stop to consider that doubling the velocity of a stream means

increasing its transportation power sixty-four times, we realize what a power we are trying to combat. We shall return to this topic.

Once the tropical downpour of warm rain has stripped off the soil, weathering can and does strike deeper into the core of rocks beneath, and however far we go underground in mine workings we find the rocks exhibiting incipient decomposition. The writer knows this to be true from the examination of a great many thin sections of wall-rock from the deepest mines in the Archipelago. Undoubtedly the presence of organic acids, resulting from the decay of the rank tropical vegetation, hastens this decomposition. Of course, we have little or no frost, except in the highest mountains, but we do have wide ranges in temperature during the twenty-four hours and this adds to the disintegrating forces at work. Therefore, all things considered, we have reason to think that gradation, which includes degradation, is the most potent of the geologic processes at work in the Tropics.

This exessive weathering in tropical regions, where andesite and basaltic lavas are to be found, has resulted in places in the accumulation of a formation, of considerable thickness, known as laterite. This is an aluminous soil, or heavy clay, also rich in iron. When the iron exceeds 35 per cent it can be used as an ore. Vast deposits of laterite are known in India and Cuba, and some years ago an American engineer discovered a commercial deposit of this in northeastern Mindanao, in the Philippines. A study of this deposit shows that it is a product of weathering and concentration.

The work of organisms.—Nothing has been said as yet about the destructive work of plants and animals in the tropical regions, as the writer has made little personal study of the subject. There is no question but that they play no inconsiderable part in the processes of weathering and on occasion have to be reckoned with in engineering operations. We have but to call attention to Branner's [2] observations on the geologic work of ants in Brazil to remind the reader of the importance of these insects. Not only do their numerous mounds, in some cases exceeding 5 meters in height, considerably alter the topography, but they seriously undermine the subsoil so as to endanger structures. They promote weathering by opening the formations to the atmosphere and to gases. The writer has seen many ant hills in

[2] Branner, J. C., Bull. Geol. Soc. Am. 21 (1910) 449–496.

the Philippines, but none commensurate with those in Brazil, described by Branner.

The writer's attention has just been called to the very interesting investigations of Oshima [3] on Formosan termites wherein he states that *Coptotermes formosanus* secretes a milky, acidulous fluid which dissolves the lime in the mortar of brick buildings. In order to protect the buildings he advises the construction of a concrete basement floor which shall have as few seams as possible.

It also appears from such studies as have been made that certain termites occupy in the Tropics a place analogous to that filled by the common earthworms in temperate regions.

An instance of the work of winds and plants in combination may be of interest. In the recent destructive typhoon which struck Manila with such force (September 1, 1920), a great many of the fine acacia trees, which are the principal shade trees of the city, were uprooted and many sections of cement sidewalk were badly damaged as a result. These trees have widely ramifying and very shallow roots, with no tap root; consequently, with their wide-spreading tops, they became easy victims of the storm.

Corals.—The rôle that corals and coral reefs play in matters of engineering and the economic development of a country cannot be overlooked. We have already alluded to the connection between coral formations and water supply. Coral limestone is a very important source of construction material. In certain other ways coral formations are of great importance. For instance, the fringing reefs protect the shore from storm waves; also, they afford a firm foundation for future land when covered with earth, either naturally or artificially. Most of the coastal plain tracts in the Archipelago have a coral foundation which is much more stable than is mere alluvium.

STRUCTURE

Much has been written in the textbooks about structure, and most engineers are probably cognizant of the importance of this branch of geology, but as yet little has got into the literature concerning this subject in tropical regions. Naturally an engineering feat of the magnitude and importance of the Panama Canal would necessitate a most careful regard for anything which might have an effect upon both the task of construction and the

[3] Oshima, M., Formosan Termites, Philip. Journ. Sci. 15 (1919) 319.

permanence of the canal. It is not the writer's intention to allude to any of the work of the Canal Commission geologist [4] further than to advise any engineer who is working, or expecting to work, in tropical regions to give this important work considerable study.

In the Philippines we have the same sort of structures found in many parts of the world with the difference that here some of the structures are not only of recent origin but are still in the making. Where dynamic forces are at work the engineer cannot afford to be off his guard or ignorant of how they are to be recognized. The builders of the Los Angeles (California) aqueduct have very wisely studied and provided against the possible breaks which might interrupt that system, having been forewarned and forearmed by a geological study of the region, a region traversed by long parallel faults in the strata.

Faults.—In the Philippines there are many faults, some large, some small, which every mining man knows about. Does the civil engineer know about them? Can he recognize them? Are they old ones where movement has long since ceased or are they fresh and is movement likely to recur, and how will that movement be manifested? Which part will move up and which down? Is the fault normal or thrust? It makes a great deal of difference which. It can be readily seen that when it comes to railroad tunnels and water mains this becomes a serious matter. Cebu Island, for example, is apparently broken by a number of faults of considerable size, and it is the belief of some geologists that the straits between Cebu and Negros Islands are due to a down-faulted block of rock strata. Therefore, the construction of engineering works of any size on that island should be preceded by careful geologic investigations. As yet the writer knows of no engineering projects in the Islands seriously affected by faults.

During a recent geological examination of the area in the vicinity of the Montalban reservoir, Dr. R. E. Dickerson suggested to the writer the possibility of a large fault traversing it. If further detailed study of the region should reveal such a break, it would be of the utmost importance to the citizens of Manila to know it. Possibly, this could not be worked out in less than several weeks, but whatever the length of time necessary, it would be justifiable.

[4] MacDonald, Donald F., Bull. U. S. Bur. Mines 86 (1915).

All faults in the Philippines which the writer has seen are, with a few minor exceptions, of the normal type. Thrust faulting may be present.

Joints.—One of the commonest features of rock formations is jointing. The cleats in coal may be considered as jointing on a small scale. Any quarry man is of course familiar with the great, regular, smooth-walled cracks which traverse various formations for long distances and more or less in definite systems. These are both an advantage and a source of trouble. Farther on the writer calls attention to the part these play in the building of the Benguet road.

Folds.—The importance of folds in the strata, such as the syncline (basin) or monocline in the case of artesian water and the anticline (arch) in the accumulation of oil, is well known to most people nowadays; but has it occurred to many people that the ease of excavation, or the control of water, causing flooding, etc., are dependent upon the attitude of the formations? In the Philippines we have the rock strata in all conceivable attitudes, each locality presenting different conditions which must be studied locally. Of course, in this respect the Philippines and the Tropics in general do not differ from many other parts of the world. However, owing to excessive vegetation and weathering these important structural facts are often concealed even from the trained eye of the geologist.

SPECIAL PROBLEMS

Road building and maintenance.—In parts of the Tropics, and particularly in the monsoon region of southeast Asia, the seasons are sharply defined, one of practically no rain and one during which it rains in torrents. If we recall the rule that the carrying power of a stream varies as the sixth power of its velocity, we know at once we cannot take any chances with a tropical torrent. In regions of high relief we have four things to consider, and we cannot neglect any one of them. They are: Declivity or head, sudden increase of volume due to configuration of the valleys, the angle of slope of valley walls, and material and structure of the valley walls.

The writer has seen instances where the highway was placed in a valley at such a point that the road was continually menaced by the stream just below it and by the sliding of material from the slopes above. The stream is dangerous because of two things: First, because of the sapping of the water itself; and

second, because, when the velocity is doubled, it can carry particles of rock sixty-four times as large as before, and in time of freshets bowlders weighing tons are carried along, each one acting as a battering ram. No retaining wall can be expected to withstand this terrific bombardment, nor does it do so.

Again, the composition of the country rock, its structure, texture, and the state of weathering are of vital importance; and, if this weathered material slides into the cañon below, a temporary and very dangerous dam results. When the dam breaks, as it soon must with the impounding of the torrent behind it, all is swept before it. We have a remarkable example of this in the now famous Benguet Road on Luzon Island. Bued River is a small stream, little more than a creek in the dry season; it flows from 1,524 meters (5,000 feet) elevation to the sea. The valley walls are V-shaped, the average slope being probably as high as 35° or even 40°. The country rock is a badly decomposed andesite, for the most part with some tuff deposits, much jointed and with innumerable small faults, all loosened by many earthquakes. Here we have ideal conditions of instability, which were perfectly apparent to geologists; yet, so far as the writer knows, no geologist was consulted by the engineers until it was too late. The inevitable happened. First, slides continued until the slopes reached the angle of repose; then dams followed, impounding the water to a great depth; next, the dams broke and search parties were out looking for the road, buried under twenty meters of débris. Now, after many years and the expenditure of much money, a new road has been constructed by way of the old Naguilian trail. We have had to go back to the ridges, following the example of the Spaniards. Of course, if we had cared to, we might have taken a lesson from the native trails, the majority of which follow ridges.

In the matter of engineering technic involved in the construction of these roads, the writer would venture to lay emphasis on the necessity for drainage; keep the foundation of your road drained. The excellence and easy maintenance of the Hawaiian roads is due largely to the very porous subsoil and, consequently, perfect drainage. You may say that this is nothing new, that every engineer knows that; but the application of drainage in America, where the rainfall is merely a light summer shower as compared with the tropical downpour, is a different problem. As to how it should be drained, that is a matter not within the writer's province as a geologist.

Maintenance on a road constructed of poor materials is one thing, while that on a road wherein a wise selection of metal has been the rule is an entirely different thing. In this a geologist with his microscope is a necessity. Petrography, once looked upon as a mere academic study, is now indispensable to the scientific road builder. There is a pathology of rock just as there is a pathology of animal tissue. The microscope will reveal at once, and at little expense, whether or not the minerals composing the rock are sound, whether there is incipient decomposition, or a far-gone state of decay. It will show also the texture or fabric of the rock. If the rock has an ophitic texture, that is, the minerals interlaced to make up a sort of mat, then we may look for toughness. Why one rock splinters and another does not is at once made clear.

At one time the writer collected rock specimens from a number of places along one of the principal Philippine highways, and among the samples was one that yielded a briquet which when placed in the Page cementation machine did not break under two thousands blows, whereas an ordinary basalt briquet yielded at the twenty-second blow. A thin section of the fresh rock was made and examination showed that there was a small amount of secondary calcite in the rock, an alteration product of the lime-bearing silicates; it was this that furnished the excellent binding qualities. The rock was a diorite just beginning to decompose without having gone so far as to reveal this condition to the naked eye. This rock, with its holocrystalline texture and just the right amount of calcite, would make a most excellent road metal because it has two essential qualities, namely, toughness and high cementation quality. Of course, the objection of high cost will be raised at once; but no matter how the finances stand, there is never any excuse for putting worthless and unsuitable rock on a road. The proper way is to let the geologist recommend one or more kinds of material, and then the engineer may consider which he can afford to use. Many state highway departments now follow this method, and formerly the engineers of the Philippine Government always submitted their road and building materials to the Bureau of Science for the proper tests. Of late years this has not been done, and the results are beginning to appear.

Still another important factor to be considered in connection with the cementation quality of the road metal is that of the wind. During a typhoon, a storm which is much like the Gulf hurricane, the velocity of the wind is as high as 165 kilometers

(103 miles) an hour and the roads are swept literally by a natural cyclone blower and all loose material is removed as effectually as if a vacuum cleaner had gone over them. So we must consider not only the work of the deluge of rain but the combined effect of water and driving wind. Road maintenance from these and other causes is a very serious problem, in the Philippines at least, and any criticism of our highways should be tempered by a consideration of the difficulties we have to overcome.

Two chief sources of trouble in concrete mixtures in the Philippines are found; first, the fineness and generally poor quality of the sand, and second, lack of strength of the crushed rock. Both Reibling and King, of the Bureau of Science, have repeatedly called attention to these weaknesses in local concrete, as revealed by their long series of actual tests made on thousands of samples. The ultimate cause for this condition of things is found in the mineralogy and geology of the raw materials employed. Not only is the mineral composition of the sand commonly used here unsatisfactory, but also the extremely weathered condition of the materials is a matter of menace. Now it is agreed that the practical tests are of prime importance in the proving of such materials, but the examination of the sand and of thin sections of the rock is also of very great value. Such examination will reveal the cause for the failure; and, of course, this is really the most important thing of all, if we want to avoid future trouble of this kind.

The so-called "sand" oftenest used here is sand only by courtesy. The microscope reveals little or no quartz, the feldspar present is often in a far-gone condition of decay, and the predominant minerals are often dark-colored hornblendes, pyroxene, olivines, etc. To one accustomed to the clear, white, sharp Ottawa sand used in standard tests, the local sand appears more like dirt.

Reverting to the subject of landslides, a thorough acquaintance with tropical conditions will reveal at once the futility of attempting to control slides like those of the Culebra cut at Panama. Retaining walls, drainage, etc., are all makeshifts. The only practical and final solution of the problem is to increase the sliding until the walls are brought to the angle of repose where they will no longer slide. According to MacDonald, geologist of the Canal Commission, the most important types of slides were structural breaks and deformations and for this type of slide there was only one remedy that had utilitarian value

under the conditions involved, and that was applied. It consisted in making the slopes less steep by removing material from their upper parts until the balanced pressure at the foot of the slope became less than the crushing or deforming strength of the rock. In other words, the slopes were brought down to the angle of repose.

This was recently well illustrated at Eugene, Oregon, where both the formation (weathered basalt) and the rainfall simulate tropical conditions. A hillside of this material, becoming saturated with rain water, started to slice off, slide, and flow under a large lumber mill at the bottom of the slope, bulging the latter upward, completely throwing it out of alignment and even threatening the structure. The simple expedient of sluicing at the foot of the slide solved the difficulty and the material of the hill was brought to such an angle that it no longer moved.

Artesian water.—In view of the fact that a great many people have a hazy notion of what an artesian well is, the term is here defined. An artesian well is a type of well first bored, as far as we know, in Artois, France, and when the word artesian is correctly employed we mean a deep well from which water flows above the mouth under more or less pressure. This pressure is due to the peculiar geological conditions obtaining in the locality. Ordinary, shallow, dug wells are not artesian.

The principles governing the concentration and movement of ground water are now well understood; but, at the risk of repetition, the writer will make a few general statements.

Although we do not see it, the sea of underground water is almost as extensive as, and in some ways more important than, the ocean. All the rocks, varying in degree of saturation, contain water down to limiting depth. Some of this water is found in the large trunk channels, joints, and faults, but a great deal of it is in the form of hygroscopic water; that is, water held in the pores of the rock by capillary attraction.

An English geologist, H. B. Woodward, makes the statement that the quantity of water held in the chalk of England by capillary attraction is tremendous. One square mile of dry upper chalk, one yard in thickness, contains ordinarily nearly 3,500,000 gallons of water, and when saturated holds 200,000,000 gallons. Recent experimental work by Van A. Mills [5] indicates that, in saturated strata, capillarity retards fluid movements, so that water so held might not flow readily.

[5] Econ. Geol. 15 (1920) 420.

Some rocks, like the dense volcanic flows and quartzites, contain practically no water. Other rocks, like the limestone formations, have subterranean rivers passing through them, but the sandstones and chalks are the most important in this respect. A true sandstone consists of grains of quartz compacted together. The more nearly spherical these grains are, the more continuous are the openings, ignoring for the moment the cementing material which in some cases may completely close the voids. In such an arrangement of spherical grains there is always one continuous passage through the mass. Along these passages the water travels. Some sandstones have as high as 35 per cent of pore space.

The loose volcanic tuff formations of the Philippines are also great water-carrying formations. This water is generally circulating slowly in the small openings, but when the water reaches a fissure, naturally the circulation is rapid.

As the deep-seated igneous rocks are usually dense and have but little pore space, and as the fractures in these rocks have no regularity, it can be seen at once that they are poor formations in which to seek water. Water may be traveling along a fissure in such formations, and the well digger may perchance strike this fissure, but usually the chances are slim. There is no excuse for locating a well in such a formation, unless this is the only kind of rock in the region. A limestone formation is also poor, as a rule; for, while it is cavernous and contains underground streams, it is a piece of pure luck when one of these is struck. Pratt,[6] a former colleague in the Philippine geological work, found that where coral limestone was interbedded with clay layers a fairly good supply of water was available. Very often, however, shallow wells in limestone areas located near the sea would yield salt water or be dry in about half the cases. The best conditions are found in the sandstone, volcanic tuffs, and beds of unconsolidated ash.

Having found the formation, we must next consider some features in the structure of the region. The ideal condition is where the sediments form a syncline (basin), with the water-bearing stratum outcropping at a higher point than the site of the well and where there is an impervious layer of clay or shale just above the water-bearing stratum. The effect of a fault on the water circulation would be to divert the flow to springs at the outcrop, but the effect of an igneous intrusion would be

[6] Pratt, W. E., Philip. Journ. Sci. 10 § A (1915) 236.

to block the water circulation. All of these conditions must be considered, if possible, previous to the digging of the well.

It is incredible that even at this late day water should be sought with a divining rod, yet a few years ago an attempt was made to find artesian water with a divining rod in the city of Zamboanga, Mindanao. Water was not found, and an examination of the geology of the country showed that very little chance existed of a supply being tapped within a reasonable depth in the location desired. In spite of some apparently successful instances of the use of the divining rod, the employment of this device may be classed with other pseudo-scientific operations, such as palmistry and astrology.

Probably the Bureau of Public Works has paid more regard to the geology of the country than any other engineering organization in the Philippines; and, so far as its wells have been dug in the Manila central plain, good results have been obtained. But the writer wishes to emphasize this fact; that, in spite of all the practical experience of a well driller, there are many more things to be taken into consideration than simply those that pertain to digging the well.

Some years ago at Olongapo, Luzon, a well was drilled on the Naval Reservation; the writer, when visiting the place, examined the cuttings in the drill and found the material to be diorite, which is the basal formation of the island and contains very little water, having no regular continuous water-passages. The well digger drilled here for twenty-two months. No water was found, and in the end he lost all his tools in the hole. As the driller was paid by the foot, he, of course, did not have to pay the bill.

In parts of the Hawaiian Islands water has been found by sinking through the overlying formation, largely consisting of lava, to the ash beds that lie buried below. The water here is ponded in this loose formation by the coral reefs bordering many parts of the Islands. The same conditions, no doubt, could be found in other tropical countries.

At the present time geologists are engaged in the Hawaiian Islands in attempting to locate high level sources of water to be brought down for irrigation purposes. Some success has been met with by bringing water through tunnels from the rainy sides of the various islands to the drier sides. It should be pointed out here that if the geologist is expected to predict the finding of water in such regions with any degree of certainty unfair advantage is being taken of him. The conditions in predominantly lava formations are too uncertain to permit of

the more nearly exact work possible in the stratified rocks. The geologist can do many things, but he is not gifted with second sight.

Dams and reservoirs.—The geological conditions affording the best sites for dams and reservoirs have also been discussed by several writers. With reference to this phase of the subject, the writer wishes to state that a geological examination of a district and several years of stream gauging are not only desirable but imperative in the Tropics. Many examples of how these works should not be located could be cited, but two or three will suffice. The city reservoir at Montalban, Luzon, was located in a limestone gorge. The limestone is full of caverns and the reservoir failed to hold water until it was lined, bottom and sides, with cement. If the dam had been placed at the upper end of the gorge the reservoir would have had a natural clay bottom.

The destruction some years ago of the Tarlac (Luzon) dam probably could not have been foreseen, but if a few more data concerning annual precipitation and stream discharge had been secured the trouble might have been averted. Agno River when under full head is a terrible engine of destruction. Another dam was built in the hills back of Cebu, making use of an apparently substantial formation for abutments and spillway. Drilling was recommended by the geologist who examined it; but no, that would be too expensive. The abutments held in a terrific storm that ensued; but the spillway, which was too small, forced the water to eat its way down through a decomposed formation which had a hard shell on the outside, so that the dam was rendered useless. The writer, from his observations in the Philippines, should be inclined to say *never* when it can be avoided build a reservoir in the Tropics. If water is needed, use diversion weirs in the streams or artesian wells.

Coal mining.—The writer had not intended to touch on any phase of the application of geology to mining engineering in this article for the reason that the connection between the two is so generally recognized. There is one particular phenomenon that has given more or less trouble to those who would work coal seams in the Far Eastern Tropics. It has been the writer's experience throughout some years of examination of coal prospects and mines in the Tropics that the persistence of a given seam of coal is always a matter of conjecture. The seams are either interrupted by small faults or they thin, or "peter out," just when you are counting on a good working thickness.

We have great rainfall over most of Malaysia to-day. There is every reason to suppose that this has been the case throughout most of the Tertiary period, which is the age of the tropical Malaysian coal. These great deluging downpours of rain mean coarse sedimentation and frequent interruptions to the quiet accumulation of vegetal matter from which we are to hope for a future coal deposit. We do find that the character of the underlying and overlying beds in the neighborhood of these uncertain coal beds is very variable; coarse and fine strata alternate with, in many places, no great thickness to any one stratum. So the advice to the engineer or geologist who is sent out to examine a coal deposit in any part of the Tropics is this: Examine carefully the nature of the inclosing strata, the character of the grains, their size and arrangement, and take nothing for granted; put down test pits or drill holes fairly closely spaced and, better still, drive on the coal. The reader who would care for more detailed discussion of this topic will find an admirable paper on the subject by Pratt.[7]

Geodesy.—Over fifty years ago there appeared in the Transactions of the Royal Society [8] several articles by the Bishop of Calcutta, a mathematician and physicist of no mean repute, relating to the perplexities then confronting the surveyors in control of the great Trigonometric Survey of India. This, one of the greatest of surveys, has recently been completed. The problem that confronted them was how to account and allow for a very noticeable and very important discrepancy between the trigonometrically located stations and those ascertained by astronomical determinations.

It was expected that the great mass of the Himalayas would deflect the plumb bob toward them, but another factor entered into the problem which at first was not understood, namely, density. There was for some reason a deflection of less amount of the negative sign which could not be accounted for; it was finally accounted for by assuming a deficiency of gravity beneath the mountain mass and a greater gravity beneath the sunken area to the south. The whole question is intimately bound up with the theory of isostasy, which is too complex a subject for review in this paper.

In 1906 Hayford [9] wrote a paper, in which the whole question is reviewed and the theory of isostasy clearly substantiated.

[7] Pratt, W. E., Philip. Journ. Sci. § A 10 (1915) 289.
[8] Phil. Trans. Roy. Soc. London (1853).
[9] Hayford, John T., Proc. Washington Acad. Sci. 8 (May, 1906) 25–40.

In the course of the coast survey of the Philippine Islands, also, considerable discrepancies were frequently noted between the trigonometrical and the astronomical location of stations, in some places amounting to 30 or 40 seconds of arc; such a difference might mean a matter of one-fourth mile or more on the surface of the earth. How to adjust this has been a matter of some difficulty. The great piles of volcanic rock constituting the Zambales Mountains suffice to explain the discrepancies at some of the stations on the west coast of Luzon. Near Olongapo, it was found that the plumb bob was deflected to the west instead of to the east, though the main mass of the Zambales Mountains lies to the east. An examination made by the writer several years ago on the Cinco Picos Range, which lies to the west of Olongapo, revealed the fact that these mountains are made up of one of the densest rocks known, periodotite. This rock has a density of over 3, whereas the main mass of the rock in the Zambales Range to the east has a density of only about 2.5. Therefore, apparently, this discrepancy is explained by our knowledge of the geological features of the two regions.

The work of Hayford has shown so clearly the importance of the data of geodesy in the solution of problems of geophysics that geologists interested in these broader and fundamental problems, such as that of isostasy, cannot afford to ignore them. On the other hand, from the example cited, the dependence is clearly seen to be mutual. The writer is planning to carry a small gravity instrument into the interior of Luzon on some of his expeditions within the coming year, as we have no data of this kind from the interior.

Physiographic influence upon economic development.—Under this topic it is proposed to cite several examples of how a knowledge of the geologic and physiographic conditions would be of direct practical value in other matters, aside from its more obvious applications to mining, and so forth, already given. The relation to engineering here is only indirect.

Cebu Island, one of the Visayan group of the islands of the Philippine Archipelago, is long, narrow, and mountainous. It has an interrupted narrow strip of coastal plain on which practically the entire population of the island (the most populous in the Archipelago) may be found. The people are comparatively poor and live largely on and by the sea. There is at present, owing to conditions produced by the war, a partial refutation of this statement. There is little productive "hin-

terland," or back country. The interior is high, rugged, and sparsely inhabited.

Near the sea, in places within a few meters of it, runs a first-class macadamized highway and, parallel with this man-made highway and the sea (the cheapest highway of all), a railroad has been built which has a spur running up to the Danao-Compostela coal field. Except the freight to and from the mines there is very little to haul over this railroad. Had it not been for the Government guarantee of 4 per cent, this venture would have been a great loss to the investors. A railroad cannot, except under unusual conditions, compete with transportation by sea, and it must have productive back country to feed it.

Although Magellan discovered the Philippine Archipelago by first landing at Cebu and although a large and prosperous city is there to-day, the physiographic advantages of the position of Manila are so superior that it has been able far to outstrip its southern rival, notwithstanding the fact that Manila as a Spanish city was not founded till nearly a half century later. Cebu is a distributing point and has to draw upon neighboring islands. In Manila we have a remarkable juxtaposition of sea, excellent harbor, river, mountain, and plain (affording a productive hinterland) which has led to the development here of what is fast becoming the most important city of the Orient.

Seismology.—Earthquakes are not confined to the Tropics. Nevertheless, many regions of great seismic disturbances are either within the Tropics or not many degrees removed. There may or may not be any direct connection between these facts. It also happens that many of the geologically newer parts of the earth are within this zone. In view of the great engineering works built at Panama, in the Hawaiian Islands, in the Philippines, and elsewhere it is of prime importance to understand the principles controlling earthquake phenomena. The damage done at San Francisco by the slip along the San Andreas rift, the catastrophes of Messina and Avazzano, and the lesser disturbances that have occurred in the Philippines from time to time should force us to pull our heads out of the sand and look facts squarely in the face. Real estate boosters as a rule do not readily fall in with this idea.

For the benefit of the possible lay reader a few elementary facts are here repeated. Earthquakes are due to three causes; namely, rockfall, vulcanism, and slips along fault planes. These

are called tectonic. Those of the last group are most numerous and most destructive. The San Francisco earthquake of 1906 was of this class.

In an investigation conducted for many years by Father Saderra Masó, of the Philippine Weather Bureau, and the writer, we found that of the great number of earthquakes that occurred in the Philippines from 1599 to 1909 only a comparatively small number could be traced to volcanoes; that of the twenty-five seismic districts in the Islands only five are near or include active or dormant volcanoes; and that two regions of greatest seismicity have no volcanoes at all.

Recently some very interesting and important conclusions concerning the connection between seismic phenomena and rainfall have been put forward by M. G. Zeil,[10] formerly topographer and geologist of the Government of French Indo-China and now of the Carte Geologique of France. This investigator asserts that seismicity in various parts of the world increases with rainfall. He mentions only one notable exception, the Valley of the Amazon, where, although the rainfall is heavy, seismicity is feeble. He cites, especially, the example of Agusan Valley in the Philippines to which Saderra Masó and the writer called attention some years ago, though not connecting the fact with the rainfall of the region.

It appears that the rapid loading and unloading of a given piece of terrain by a heavy rainfall which is discharged quickly into the lowlands or the sea, effecting considerable erosion, is the prime factor in many of the sudden adjustments in the outer shell of the lithosphere. In a heavily forested region like the Amazon the run-off of the streams is slow and consequently erosion is comparatively slight.

The rainfall would have still another effect, that of lubrication, thus causing slipping of one formation, or of the beds of the same formation, over one another.

M. Zeil in a letter to the writer has pointed out that in Annam, in those places where the natives have cut away the forests, the number and frequency of earthquakes have increased. Here is a splendid example of the need for coöperative investigations on the part of the engineer, the forester, the seismologist, and the geologist.

This particular subject is one to which we have as yet devoted little attention in the Philippines, but we shall in the future

[10] Zeil, M. G., Acad. des Sci., Seance de 12 juillet (1920) 117–119.

attempt to follow up these most interesting suggestions of M. Zeil.

There are three things we must do in order to cope with earthquakes. The most obvious thing is in the line of engineering. We must build structures so tied together that the parts will not fly into fragments, and the material must be elastic. The safest and cheapest type of construction is the native house of bamboo wherein rattan takes the place of nails. Sand-lime brick securely tied to a steel frame, and reënforced concrete, are the most suitable for large buildings. Volcanic tuff (locally quarried as Guadalupe stone) is one of the best cheap materials I have yet seen. The walls and many of the older public buildings of Manila are constructed of this stone.

Aside from the class of building material to be used, is the all-important question of the nature of the ground on which large structures may safely be erected. The investigations of the California Earthquake Commission revealed very conclusively the dangers from "made ground" in regions subject to earthquakes. Nevertheless, in spite of their findings, of which any up-to-date engineer ought to have knowledge, we see right here in Manila large five- and six-storied structures (it is true they are of reenforced concrete) being erected on made ground or on river alluvium which is none too stable. Buildings of the skyscraper type, such as the Luneta Hotel, are nothing less than a defiance of good engineering sense. Piles and test borings have not yet been able to bottom on the Luneta. In fact, practically the whole of Manila is located on loose sand saturated with water. Indeed it is impossible to bury the dead below ground in most sections of Manila because of this fact. In such material large structures are subject to settling and they do settle. Furthermore, since seismic waves travel with the greatest acceleration and amplitude in loose formations, the displacement due to earthquake motions will be greatest on ground of this kind. Three or four stories ought to be the limit of height for buildings in Manila. The writer is glad to say that the city engineer of Manila (a Filipino) has tried to have an ordinance passed limiting buildings to five stories. This is certainly the absolute limit of safety in this country.

The geologists of countries subject to seismic disturbances must be instructed and must be afforded ample opportunity, in connection with their economic work, to map the geological details, such as formations, contacts, joints, faults, etc., in order that we may have data from which to draw conclusions of

importance. The work of the Italian geologists in Calabria and Sicily in this particular field of investigation has given us a fine example of what to do and how to do it.

Finally, as volcanic eruptions and tectonic earthquakes may both be connected with deep-seated phenomena in the earth magma, it behooves us to proceed vigorously and continuously with detailed volcanological studies along the lines laid down by Perrett, of the Vesuvius Observatory; Omori, of Japan; and Jagger, of the Volcano Observatory of Kilauea, Hawaii. If we do this we shall have a collection of data which in time will enable us to cope with these dreaded phenomena as we now do with the typhoon.

SUMMARY

1. The geological agents at work in tropical regions are the same as those found operating in temperate parts of the earth, with the difference that they are often greatly accelerated in the former.

2. In the Philippines structural conditions are of prime importance in engineering. Both major and minor faulting occur here which as yet have not caused trouble save in mining operations.

3. Both road location and maintenance in tropical countries like the Philippines are much more difficult than in the United States and Europe.

4. Dams and reservoirs should be avoided when possible in countries like the Philippines.

5. The instability of the Philippine geological structure is established.

6. Weathering of the rocks in tropical regions is notable. The so-called laterite, in some places of considerable economic importance, is a product of weathering. It is characteristic of many tropical countries.

7. The geologic work of organisms is great in the Tropics, though but little studied.

8. The work of tropical rain and running water is not appreciated as it should be.

9. Handbooks and formulæ prepared by engineers acquainted only with conditions in temperate regions are worse than useless in the Tropics. They are positively dangerous.

10. Engineers as a whole should, if possible, give more attention to the study of modern geology which is no longer merely a descriptive subject but is becoming more and more a close relative of engineering.

NOTES ON PHILIPPINE TERMITES, I

By S. F. Light

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The social insects known as termites, "white ants" or, in Philippine dialects, as *anay*, constitute a distinct order, the Isoptera. They are most nearly related to the Orthoptera and Neuroptera and, within the former order, to the Blattidæ, or cockroaches. They are, therefore, among the more primitive of insects, as regards structure and life history, which but makes the more impressive the high development of social instincts and habits and the striking polymorphism and division of labor which characterize the group. In structure and development they are far removed from the true ants, of the order Hymenoptera, and as has been often pointed out the only reasons for the name "white ants" are that they form large colonies with a highly developed division of labor and specialization of castes, build mounds or nests, and display a complex social system—all suggestive of conditions among the true ants.

The termites present splendid opportunities for the study of social habits and instincts and are at the same time of very great economic importance because of the enormous damage caused by their attacks on wooden structures and even living trees and shrubs. Hence any work on termites—systematic, morphological, ecological, or faunistic—is of practical value and may have a direct, present-day bearing on human welfare.

The literature dealing with termites is very extensive. The works of outstanding importance are those of Smeathman (1781), Hagen (1855–1860, who gives a complete summary of all earlier work), Grassi and Sandias (1893), Froggatt (1895–1897), Sjöstedt (1896–1914), Wasmann (1896 to the present time), Haviland (1898), Silvestri (1901 to the present time), Banks (1901 to the present time but particularly his "A Revision of the Nearctic Termites," 1920), Heath (1903 and 1907), Desneux (1904–1907), Holmgren (1906 to the present time), Escherich (1908 and 1912), Bugnion (1910–1915), Oshima (1910 to the present time), Andrews (1911), Snyder (1912 to the present time), Fuller (1912 and 1915), Hill (1915

to the present time), Hozawa (1915), Thompson (1916 to the present time), and others.

In spite of the many and extensive studies which have been made on termites, the ecological field is barely touched, and much remains to be done along systematic and economic lines. This is particularly true in the Tropics, where termite life reaches its climax, and most strikingly is it the case in the Philippine Archipelago, where systematic study has been only begun and little has been done along biological lines.

Led but recently into this fascinating field of study through an investigation of the protozoan parasites which are found in the intestines of the more primitive genera, I regret that my study of the termites was not begun many years ago. They furnish an ideal combination of theoretical and practical interest. The strangeness of form and the variety in shape of the different species, particularly of their soldiers, the high development of caste and division of labor, the fascinatingly interesting glimpses of a complex social development based on instinct, the ever-present problem of lessening or preventing their inroads on wooden structures—all combine to make this one of the most compelling and profitable fields of insect study. This is particularly true in a region where the termites are all around one, where there is hardly a house but shows signs of their ravages, where any dead limb or stump, or piece of waste wood, or the very chair on which you sit may harbor a colony, perhaps of a species as yet unknown to science, at least interesting in all the details of its complex life and as yet practically unstudied.

The Philippine termite fauna is apparently very rich. This might be expected when we consider the large number of islands, the great variety of habitat, and the luxuriance of plant life.

In this set of Notes on Philippine Termites, I plan to work over the systematic field until all but the rarest species are thoroughly known. Ultimately, I hope to monograph our Philippine termites with full descriptions, illustrations, and keys. Such economic and biologic data as accumulate from time to time will also be published, and when the systematic work is on a firm basis I hope to publish the results of more extensive economic and ecologic investigations.

CLASSIFICATION

The classification of termites is in a superficially unsatisfactory condition due to various causes. This condition has resulted mainly from failure to follow more or less widely

accepted rules of nomenclature, from failure to investigate generic types and designate them in the case of new genera, and from lack of clear definitions of generic and subgeneric groups, as well as from the inherent difficulties involved in systematic work in a group where polymorphism occurs and where it is often necessary to establish species and even genera without all the variants, the adult or the soldiers being unknown in many cases. Conservatism on the part of the older workers in the group and a dislike to make radical changes in well-established generic names is easily understood and to be expected, and it may be said before going any further that the system of classification due mainly to Holmgren, and in part to Silvestri, Wasmann, Froggatt, and others seems to present a very natural arrangement of the families and genera of termites. Banks,[1] however, in a recent monograph on Nearctic termites, not only has presented a new grouping of the genera but has made radical changes in generic names based on a study of type species. *Odontotermes* and *Microcerotermes,* for example, become synonyms and are replaced, respectively, by the older generic names *Termes* and *Eutermes,* at present applied to other and very large groups.

Such a condition places the beginner in the field in a most unfortunate position. He recognizes on the one hand, the splendid results of the older workers and sympathizes with their very natural sentiments with regard to names of long standing, which are recognized by practically all termitologists; but, on the other hand, he sees the need and the great importance of definite rules of nomenclature. Therefore, he stands, as it were, at the parting of the ways, hesitant as to the path he shall follow, lacking that confidence which can only come from a mature knowledge of the field and, hence, feeling a natural temerity at the idea of attempting to change long-established usage but, on the other hand, lacking that sentiment for the older names so natural to one to whom the work of years has endeared them and, especially if a younger man, he finds himself facing a most unpleasant dilemma.

If further researches show that Banks's contentions as to generic types are justified, it seems inevitable that the changes in generic names which he proposes must in part at least be adopted. Not being able to verify them myself, however, I shall

[1] Banks, Nathan, A Revision of the Nearctic Termites, Bull. U. S. Nat. Mus. 108 (1920).

retain the older names until a more mature knowledge of the group or further researches on the part of other workers or consensus of opinion makes necessary the radical changes in generic names involved.

Several of the larger genera, *Calotermes, Termes,* and *Eutermes,* contain quite distinct subgroups which it has been customary to consider as subgenera, the result being cumbersome tripartite names. The recent tendency has been toward considering these groups as genera whenever possible, a tendency which makes for simplicity and greater ease in classification.

With regard to families, the divisions of Holmgren seem to fulfill the requirements of a natural classification but the names Protermitidæ, Mesotermitidæ, and Metatermitidæ, not being based on type genera, must ultimately be replaced, preferably by Kalatermitidæ, Rhinotermitidæ, and Termitidæ, respectively.

With regard to the use of adult characters or those of soldiers for classification, I agree with Banks to the extent that I believe the divisions between larger groups and the ultimate classification of the group as a whole should be based on the characters of the adult as being phylogenetically the typical form; but for practical purposes and for preliminary classification the characters of the soldiers are available and will be used by me, as indeed they are by him and all other systematic workers on termites. Were we to wait for the collection of the adults of the different species, we should be halted indefinitely in our study of Philippine forms, for the imago is unknown for nearly two-thirds of the species so far reported from the Philippines. Indeed, after some little collecting experience I am compelled to wonder at the almost marvelous success of Haviland in obtaining queens and winged adults under somewhat similar conditions.

Hagen,[2] in his very complete survey of the literature dealing with termites, mentions three very early descriptions of Philippine termites. I give them here because of their local historical interest rather than for their scientific value.

The first of these, and probably the first mention in literature of Philippine termites, is by Nieremberg[3] in 1635 and consists of a description of an "ant" from the Philippines under the name of *sulum,* which Hagen believes to be a termite.

The second of these early notices of Philippine termites is

[2] Hagen, Linnea Ent. 9–12 (1855–1860).

[3] Nieremberg, Histor. nat. 1635, fol. lib. 13, cap. 13, p. 28." Hagen, Linnea Ent. 10 (1855) 19.

found among descriptions of animals, etc., in a History of Mexico by Hernandez, published in 1651.[4] Here again the animal concerned is given the name *sulum* and is believed by Hagen to be the same termite.

The third and last of these early descriptions of Philippine animals believed by Hagen to refer to termites is found in an article, describing various Philippine animals, written by the Jesuit Father Camel (Camelli) and communicated by Petiver[5] in 1709 to the Royal Philosophical Society of London.

According to Hagen, who quotes extensively, Camelli gives descriptions of fourteen species of "ants" from the Philippines, of which Hagen believes that five possibly apply to termites. The first of these he believes to be the same as the *sulum* of Nieremberg and of Hernandez and gives it the name *bondoc* which means in Philippine dialects "mountain" or "hill" and is never used to mean ant or termite. It seems probable that Father Camelli misunderstood his informants and substituted the name of the habitat for that of the animal. The description he gives seems to suggest a termite, particularly with regard to the size of the queen or, as he puts it, the king and the form of the nest. The animals, however, are spoken of as being black. Hagen believed this to be a description of *Termes carbonarius,* which is darker than most termites. Unfortunately for this surmise, *T. carbonarius* has not been recorded from the Philippines. While this does not by any means prove that the species does not exist here, it suggests that *T. carbonarius* is not among our common forms, and consequently it is rather improbable that specimens of this species were found among the first known termites.

But for their habitat ("cushions and pillows!"), which has never been noted for a termite, the second of these descriptions might well apply to one of the smaller wood-attacking species, such as those of the genus *Coptotermes* or *Microcerotermes,* since he describes the insects as small, white, and about the size of a louse. To these he gives the name *cuyutil,* which I have not been able to place in any Philippine dialect, and speaks of the insects as living in cushions and pillows where they make their nests of clay. The word *cuitib* is used in Tagalog for

[4] "Hernandez, animalium etc. Mexican. historia Romae. fol. 1651, im angehängten liber unicus etc., p. 76." Hagen, Linnea Ent. 10 (1855) 29.

[5] "De variis animalibus Philippinensibus ex Mss. Geo. Jos. Camelli communicavit Petiver. Philos. Transact. 1709, vol. 26, No. 318." Hagen, Linnea Ent. 12 (1858) 247.

a very small red ant and it is barely possible that this has been distorted into cuyutil.

The next two descriptions seem to apply to some lac-forming insects rather than to termites, since they are called *lac-ha* and are spoken of as forming a gumlike mass; and, aside from their living in trees, there is nothing in the descriptions which would seem to place them as termites.

The last of the descriptions, and the only one which is undoubtedly that of a termite, refers to the terrible destructiveness of the insect to wooden structures, clothes, books, etc., and here for the first time we find recorded the name *anai* or *anay* almost universally applied to termites in Philippine dialects. It is, however, quite impossible to determine from the description which termite is here referred to, and one is led to believe that much of hearsay is mixed with a modicum of fact.

In the systematic portion of his monograph Hagen records only a single termite species, *Termes dives* Hagen,[6] from the Philippines. His species was based on adult material from the Philippines and Java and has been shown by Holmgren [7] to belong to the genus *Odontotermes*, and the soldiers described by Hagen to belong to *Termes gilvus*. It has not as yet been identified with any of our known forms.

The soldiers, larvæ, etc., collected in the Philippines by Heer and placed by Hagen under *Termes* are placed by Holmgren [7] under the common Malayan *Macrotermes* species, *Termes gilvus*. This would seem to be Oshima's *T.* (*M.*) *copelandi* and it seems probable that the latter name must be considered a synonym of the first. Further study of a wide range of material will be necessary to clear up this point.

The next species to be reported from the Philippines was *Termes distans* Haviland, reported by him in 1898 [8] from the Sulu Islands.

Since Haviland's paper the only systematic work on Philippine termites has been done by Oshima, who has published descriptions in four different papers.[9]

The only biological work on Philippine termites consists of a paper by Uichanco (1919) [10] on the biology of the common mound-

[6] Hagen, Linnea Ent. 12 (1858) 139–142.

[7] Holmgren, Kungl. Sv. Vet. Akademiens Handlinger 50, 2 (1913) 131.

[8] Haviland, Journ. Linn. Soc. London 26 (1898) 401, 402.

[9] Oshima, Annot. Zool. Jap. 8 (1914) 553–585; Philip. Journ. Sci. § D 9 (1916) 351; 12 (1917) 217–225; 17 (1920) 489–512.

[10] Uichanco, Philip. Journ. Sci. 15 (1919) 59–65.

building form, probably *Termes* (*Macrotermes*) *copelandi* Oshima or *philippinensis* Oshima, and a paper by Brown (1918)[11] on the fungi cultivated by the mound-building termites identified by Oshima[12] as *Termes* (*Macrotermes*) *philippinensis* Oshima.

To date there have been reported from the Philippine Islands thirty-three species of termites; thirty by Oshima and one each by Hagen, Haviland, and Holmgren. Oshima's first Philippine material was collected by Prof. C. F. Baker, dean of the College of Agriculture, University of the Philippines, at Los Baños, where the College is located. That for his last three papers was collected by Mr. R. C. McGregor, associate editor of the Philippine Journal of Science, at present acting director of the Bureau of Science. Mr. McGregor has shown the greatest interest in my work as also in the previous termite work. He has been an invaluable aid both by personal collecting and by helping me to make collections as well as by his unflagging interest and enthusiasm. I wish to take this opportunity of expressing my appreciation for what he has done and, I feel certain, will continue to do to aid in the study of our termite fauna.

A list of the species reported from the Philippines forms a part of this paper. I do not feel ready to give the species the names which recent changes in the knowedge of generic types and diagnoses and a fuller comparative knowledge of our termite fauna may well require. I have therefore given them the scientific names under which they were reported from the Islands. The names and date or dates in parentheses refer to the reporter and date when reported.

Following each species the following data are given: 1, original locality; 2, distribution within the Archipelago and collectors; 3, distribution outside the Archipelago; 4, habitat notes; 5, imago, whether known or unknown.

Mr. Baker's material and that of Mr. McGregor, with the exception of one collection from Panay, was all collected within a radius of 65 kilometers of Manila. Therefore, collections having been made in but two islands, and in very limited regions of each, the distribution data will have but little faunistic value. It is hoped, however, that our future collecting may be sufficiently thorough to allow for the ultimate drawing of conclu-

[11] Brown, Philip. Journ. Sci. § C 13 (1918) 223–231.
[12] Oshima, Philip. Journ. Sci. 17 (1920) 489–512.

sions as to species range, faunal affinities, migration routes, etc.; the present data are given here merely to form a starting point for future studies on distribution.

TERMITES REPORTED FROM THE PHILIPPINES

Calotermes (Neotermes) malatensis Oshima, 1917. (Oshima, 1917, 1920.)
Original locality: Manila.
Philippine distribution: Luzon, Manila (*McGregor*).
No foreign distribution known.
"From a decayed limb of a small tree (*Samanea saman* Merrill)."
Imago known.

Calotermes (Neotermes) lagunaensis Oshima, 1920.
Original and only known locality: Luzon, Laguna Province, Paete (*McGregor*).
Imago unknown.

Coptotermes flavicephalus Oshima, 1914. (Oshima, 1914, 1916.)
Original and only known locality: Luzon, Laguna Province, Los Baños (*Baker*).
Imago unknown.

Coptotermes formosanus Shiraki, 1909. (Oshima, 1920.)
Original locality: Formosa.
Philippine distribution: Manila (*McGregor*).
Foreign distribution: Formosa, China Coast, and Japan.
"Formosa's most destructive termite."
Imago known from Formosa and Japan but not from the Philippines.

Coptotermes travians (Haviland, 1898). (Oshima, 1920.)
Original localities: Singapore and Sarawak.
Philippine distribution: Luzon, Manila (*McGregor*); Panay, Antique Province, Culasi (*McGregor*).
Foreign distribution: Malay Peninsula and Borneo.
"Making covered tunnels on telephone posts." "Attacking house posts, floors, clothing, and papers."
Imago known but not from the Philippines.

Rhinotermes (Schedorhinotermes) bidentatus Oshima, 1920.
Original and only known locality: Panay, Antique Province, Culasi (*McGregor*).
"Living in a decaying log in the forest."
Imago unknown.

Rhinotermes (Schedorhinotermes) longirostris (Brauer, 1865). (Oshima, 1916.)
Original locality: Nicobar Islands.
Philippine distribution: Luzon, Laguna Province, Paete and Sarai near Paete (*McGregor*).
Foreign distribution: Celebes and Nicobar Islands.
"Found in tunnels in a much decayed log."
Imago unknown from the Philippines.

Rhinotermes (Schedorhinotermes) tarakensis Oshima, 1914. (Oshima, 1920.)
Original locality: Tarakan, Dutch Borneo.
Philippine distribution: Luzon, Laguna Province, near Paete (*McGregor*).
Foreign distribution: Borneo.
Living "under a hard, round, black nest."
Imago unknown.

Termitogetonella tibiaoensis Oshima, 1920.
Original and only known locality: Panay, Antique Province, Tibiao (*McGregor*).
"Living in an old log."
Imago known.

Termes (Termes) copelandi Oshima, 1914. (Oshima, 1914, 1916, 1920.
Termes (*Macrotermes*) *copelandi* Oshima, 1920.
Original locality: Los Baños.
Philippine distribution: Luzon, Laguna Province, Los Baños (*Baker*); Manila (*McGregor*); Rizal Province (*McGregor*); Palawan (*Schultze*); Panay, Capiz Province, Ibajay (*McGregor*).
No foreign distribution known as such but if, as seems probable, this is *Termes gilvus*, it is widespread throughout the East Indies.
"Forms broad low clay mounds." "Makes earthen runways over trees and shrubs eating their bark." One of the commonest mound-building termites, if not the only common mound-building species.
Imago unreported as such.
Common throughout East Indies.

Termes dives Hagen, 1858.
Original locality: Manila (*Baron von Huegel, Heer, Chamisso*).
Philippine distribution not known.
Foreign distribution: Common throughout East Indies.
Imago known.

Termes gilvus Hagen, 1858. (Holmgren, 1913.)
Probably the same as *T. copelandi* Oshima.

Termes (Macrotermes) luzonensis Oshima, 1914. (Oshima, 1914, 1916, 1920.)
Original locality: Los Baños.
Philippine distribution: Luzon, Laguna Province (*Baker*); Rizal Province (*McGregor*).
No foreign distribution known.
"Builds large earth mounds and makes tunnels on *Artocarpus*." Probably a form of *T. copelandi* or *T. gilvus*.
Imago (queen) known but not described.

Termes (Macrotermes) manilanus Oshima, 1914. (Oshima, 1914, 1916, 1920.)
Original locality: Manila.
Philippine distribution: Luzon, Manila (*C. S. Banks*); Laguna Province (*McGregor*); Panay, Antique Province, Culasi (*McGregor*).
No foreign distribution known.
Known only from winged imago.

Termes (Macrotermes) philippinensis Oshima, 1914. (Oshima, 1914, 1916, 1917, 1920.)

Original locality: Los Baños, Laguna Province.

Philippine distribution: Luzon, Laguna Province (*Baker*); Manila (*McGregor*); Bulacan Province (*McGregor*); Panay, Antique Province, Culasi (*McGregor*).

No foreign distribution known.

"Builds large earth mounds. Makes tunnels on *Artocarpus*."

Imago known.

Common throughout East Indies.

Odontotermes mediodentatus Oshima, 1920.

Original and only known locality: Paete, Laguna Province (*McGregor*).

Imago unknown.

Eutermes (Hospitalitermes) hospitalis (Haviland, 1898). (Oshima, 1920.)

Original locality: Sarawak, Borneo.

Philippine distribution: Luzon, Rizal Province, San Francisco del Monte (*McGregor*).

Foreign distribution: Malay Archipelago, Borneo.

"Day foragers."

Imago known from Borneo but not from the Philippines.

Eutermes (Hospitalitermes) luzonensis Oshima, 1917. (*E.* [*H.*] *hospitalis* of Oshima, 1916.) (Oshima, 1917, 1920.)

Original locality: Sarai, near Paete, Laguna Province.

Philippine distribution: Luzon, Laguna Province (*McGregor*); Rizal Province (*McGregor*).

No foreign distribution.

"Day foragers."

Imago not known.

Eutermes (Hospitalitermes) saraiensis Oshima, 1916.

Only known locality: Sarai, near Paete, Laguna Province (*McGregor*).

Imago unknown.

Eutermes (Ceylonitermes) mcgregori Oshima, 1916. (Oshima, 1916, 1920.)

Original locality: Sarai, near Paete, Laguna Province.

Philippine distribution: Luzon, Laguna Province (*McGregor*); Panay, Antique Province (*McGregor*).

No foreign distribution known.

"In decayed wood."

Imago known.

Eutermes (Eutermes) balintauacensis Oshima, 1917. (Oshima, 1917, 1920.)

Original locality: Balintauac, near Manila, Rizal Province.

Philippine distribution: Luzon, Laguna Province (*McGregor*); Rizal Province (*McGregor*).

No foreign distribution known.

"Covered tunnels on *Caesalpinia sappan* Linn."

Imago unknown.

Eutermes (Eutermes) castaneus Oshima, 1920.
Original locality: Sarai, near Paete, Laguna Province.
Philippine distribution: Luzon, Laguna Province (*McGregor*); Panay, Antique Province (*McGregor*).
No foreign distribution known.
Imago unknown.

Eutermes (Eutermes) gracilis Oshima, 1916. (Oshima, 1916, 1920.)
Original locality: Sarai, near Paete, Laguna Province.
Philippine distribution: Luzon, Laguna Province (*McGregor*).
No foreign distribution known.
Imago unknown.

Eutermes (Eutermes) las-piñasensis Oshima, 1920.
Original locality: Sarai, near Paete, Laguna Province.
Philippine distribution: Luzon, Laguna Province (*McGregor*); Manila (*McGregor*); Rizal Province (*McGregor*); Bulacan Province (*McGregor*).
No foreign distribution known.
"Makes wide covered tunnels over *Pithecolobium* and *Barringtonia* which it attacks."
Imago unknown.

Eutermes (Eutermes) manilensis Oshima, 1916.
Original and only known locality: Manila (*C. S. Banks*).
Imago unknown.

Eutermes minutus Oshima. (Oshima, 1917.)
Reported from Las Piñas, Rizal Province (*McGregor*).
"Inside an old log."

Eutermes (Grallatotermes) luzonicus Oshima, 1914. (Oshima, 1914, 1916, 1920.)
Original locality: Los Baños, Laguna Province.
Philippine distribution: Luzon, Laguna Province (*Baker*); Manila (*McGregor*); Rizal Province (*McGregor*); Panay, Antique Province (*McGregor*); Capiz Province (*McGregor*).
No foreign distribution known.
"Attacks *Pithecolobium, Spondias,* bamboo, cocos, and wooden parts of houses." Our commonest *Eutermes* species.
Imago unknown.

Eutermes (Grallatotermes) panayensis Oshima, 1920.
Original and only known locality: Culasi, Antique Province, Panay (*McGregor*).
"From tunnels on large tree."
Imago unknown.

Eutermes (Trinervitermes) menadoensis Oshima, 1914. (Oshima, 1920.)
Original locality: Menado, Celebes.
Philippine distribution: Luzon, Rizal Province (*McGregor*); Laguna Province (*McGregor*).
Foreign distribution: Borneo and Celebes.

"Attacks *Ficus* and *Barringtonia*, making covered tunnels from nests on ground."

Imago unknown.

Eutermes (Rotunditermes) culasiensis Oshima, 1920.

Original and only known locality: Culasi, Antique Province, Panay (*McGregor*).

"In bark of decayed log."

Imago unknown.

Microcerotermes los-bañosensis Oshima, 1914. (Oshima, 1914, 1916, 1917, 1920.)

Original locality: Los Baños, Laguna Province (*Baker*).

Philippine distribution: Luzon, Laguna Province (*Baker, McGregor*); Manila (*McGregor*); Bulacan Province (*McGregor*); Panay, Antique Province and Batbatan Island (*McGregor*); Romblon (*McGregor*).

No outside distribution known.

"One of our commonest Philippine termites. Makes hard nests at base of bamboo, cocos, *Pithecolobium*, etc., and builds tunnels over them. Occasionally attacks houses and furniture."

Imago known.

Termes distans Haviland, 1898.

Original localities: Sulu Islands and Celebes.

Philippine distribution: Sulu Islands (*Haviland*).

Foreign distribution: Celebes.

Imago known.

Capritermes paetensis Oshima, 1920.

Original and only known locality: Paete, Laguna Province, Luzon (*McGregor*).

"In damp ground under vegetable waste."

Imago unkown.

These thirty-three species of termites, recorded from the Philippines, belong to nine genera. One genus, *Termitogetonella* Oshima, 1920, is known from the Philippines only.

No less than twenty-three of these thirty-three species were named from Philippine material and are known from that region only. Which of these are truly endemic cannot be determined until we have a much more thorough knowlege of the species on the Asiatic mainland, and the East Indies. That some of them will later be found to be present in nearby regions seems most probable. That some few of them will be found to be synonymous with species already described from Borneo, Singapore, Java, Japan, Formosa, etc., seems probable, particularly in the case of species belonging to the genera *Coptotermes*, *Macrotermes*, and *Eutermes*. Such cases will probably be comparatively rare, however, due to the fact that Professor Oshima had the peculiar advantage of studying his first Phil-

ippine material in connection with numerous species from the Malay Archipelago and adjacent regions. Oshima is also an authority on Formosan and Japanese termites and hence we should expect little overlapping of specific diagnoses with that region.

Judging from the fact that most termite species have a comparatively limited range, we should expect collections made from the central area of the Archipelago to yield a high percentage of endemic species. That not only the percentage of new species but the actual number of such species is high indicates that the Islands have a remarkably rich termite fauna.

The species are distributed as follows:

Luzon		27
Laguna Province	21	
Manila and Rizal Province [a]	16	
Bulacan Province	3	
Panay		12
Antique Province	11	
Capiz Province	2	
Batbatan Island	1	
Romblon		1
Palawan		1
Sulu Islands		1

[a] The city of Manila belongs naturally with Rizal Province and will be so considered in questions of distribution.

The numbers for the different provinces and islands are not, of course, an index of the number of termite species to be found in them, but are merely an indication of the amount of collecting done. The figures are given in order to form a starting point for further investigation. Nineteen species are so far known from Luzon only, four from Panay only, and one from the Sulu Islands only. Eight species are reported from both Panay and Luzon; one from Panay, Romblon, and Luzon (*Microcerotermes losbañosensis* Oshima); and one from Palawan, Panay, and Luzon (*Termes* (*Macrotermes*) *copelandi* Oshima). These would seem to be our commonest and most-widespread species, but further study may show them to be polyspecific groups. The former is a nest-building form, and the latter builds large, low, clay or earthen mounds. It is possible that the former will be found to consist of a number of closely related species, as Haviland suggests of the corresponding Borneo and Malay Archipelago forms. Furthermore, the *Macrotermes* groups will require very extensive and intensive study before we can diagnose the species with certainty.

Of the thirty-three species of Philippine termites nine, and possibly one more, [13] have been reported from other regions. Of these but one, *Coptotermes formosanus* Oshima, is found in Formosa and Japan, and the other eight are from the East Indies and the Malay Archipelago. Six of these eight are found in Borneo and two in Celebes, showing the expected relationship of our fauna to that of those regions. Of these *Coptotermes travians* Haviland seems to have the greatest range, being reported from Ceylon and intermediate regions. Further study, however, may show our species to be distinct from that of Haviland.

The data as to interrelations of termite faunæ are so fragmentary at present as to make it impossible to speak with any surety, but we may confidently expect that further study will show our fauna to have a close relation, through Palawan and the Sulu Islands, with that of Borneo and the Malay Peninsula, and through the Babuyanes and Batanes with that of Formosa and Japan.

It will be seen that twenty-seven of the known species have been recorded from Luzon and that twenty of these were described by Oshima as new to science. The Luzon collections have been made in a very limited area within 65 kilometers of Manila, mainly in Laguna and Rizal Provinces (with the latter of which Manila should be included from the point of view of distribution), with some few from near the Rizal-Bulacan boundary. It might be expected that collections from so limited a region yielding so many new species would have exhausted the readily available new forms. On the contrary, however, collections made by Mr. McGregor and myself on four half-day trips over the same ground—that is, to Alabang, Antipolo, Balintauac, and Montalban, respectively—all type localities for many of Oshima's species—together with a few collections in and about Manila made by Mr. McGregor, myself, and some of my students show about thirty different species. Seventeen or more of these appear to be new to the Philippines and most, if not all, of these new to science. There is every reason to believe, therefore, that complete collections from the many islands of the Archipelago ranging from the Batanes in the north, which should give us an interesting intergradation with the Formosan fauna, to the Sulu Islands in the south, whose termite fauna should furnish interesting relationships with that of Borneo, Celebes, and the Malay

[13] *Eutermes minutus* Oshima, Philip. Journ. Sci. § D 12 (1917) 225. I have been unable to locate the description of this species, which is mentioned in the above paper without references or subgenus.

Peninsula, should show the Philippine Archipelago to have one of the richest termite faunas of the world and one of the most interesting for the study of variation, distribution, and faunistic relations and their bearing on the problem of evolution.

Of the thirty-three species of termites known from the Islands the adult is known for only twelve. Mr. McGregor, who collected much of Oshima's material and who is at present aiding me in my collections, concurs with me in a feeling of admiration for the success of Haviland in procuring the adult forms of so many of the species which he describes. While we hope ultimately to achieve a similar success, it is rather discouraging to seek through a nest, piece by piece, only to find thousands of eggs and immature forms but no sign of adults. This has happened so many times with the forms which have nasute soldiers that we have come to the conclusion that the queen and king must be located in some subterranean chamber from which the eggs are transported to more exposed regions to pass through their development stages.

This is but one example of the many gaps to be filled before our knowledge of Philippine termites is at all complete. Aside from its systematic interest, every one of the many Philippine species presents a fascinating problem, almost untouched, in ecology, social habits, and morphology, and several of them present economic problems of great importance. Any extensive work along such lines must, however, await a fuller knowledge of the systematic position of our termite species.

The next of this series of notes will present descriptions of several new species belonging to genera or subgenera not heretofore reported from the Philippines.

NEW RECORDS AND SPECIES OF PSYLLIDÆ FROM THE PHILIPPINE ISLANDS, WITH DESCRIPTIONS OF SOME PREADULT STAGES AND HABITS [1]

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FIVE PLATES

The present paper is based largely on the materials I collected while working with Philippine plant galls from Mount Maquiling and the neighboring plains. Prof. Charles S. Banks and the students in economic entomology at the College of Agriculture, University of the Philippines, also contributed a number of specimens.

I have made an effort to follow throughout my paper the classification which has been so carefully worked out during the past seven or eight years by Prof. D. L. Crawford, now of the College of Hawaii, Honolulu, to whom our knowledge of this interesting family of insects is largely due. The terminology adopted for designating the various morphological parts used in classification is that discussed in Crawford's monograph (Crawford '14).

The galls of five of the insects treated in the present work have been described in an earlier paper (Uichanco '19). The character of these galls differs with the causative insect, and ranges from a simple convolution or depression in leaf lamina to very highly specialized and extraordinarily complex, well-defined formations. There are also species which are not gall-makers.

The study of the immature stages of these insects has been practically neglected, although it seems to be a most promising field from both the biologic and the taxonomic points of view. The habits of the nymphs, especially as to formation or non-formation of galls and the general characters of galls formed, are apparently uniformly similar for certain groups. Likewise, a number of distinctive taxonomic characters, such as

[1] Contributions from the Bussey Institution for Research in Applied Biology, Harvard University, No. 172.

the genal cones of the Triozinæ, early become apparent in the immature forms. A thorough study of these preadult stages may result in a more reliable establishment of the true systematic position of some anomalous genera, or be of help in distinguishing certain apparently closely related groups which hitherto have been difficult to separate. In the present paper descriptions of a few of the nymphal instars and their habits are included, and it is hoped that further collecting and field observations may lead to the accumulation of sufficient material for a more adequate treatise on this phase of the subject.

Subfamily LIVIINÆ Löw

Tribe APHALARINI (Löw)

Genus **HAPLAPHALARA** novum

Head very slightly declivous; vertex less than one-half as wide as long, flat; genæ roundly swollen ventrad to antennal tubercles; frons visible as a short sclerite-bearing anterior ocellus; eyes subglobose, prominent; anterior ocellus visible only from cephalic aspect of head; posterior ocelli not elevated; clypeus large; antennæ slender, not much longer than width of head. Thorax scarcely arched, slightly thicker than abdomen; pronotum nearly half as long as vertex, not depressed below level of latter, terminating laterad almost at level of eyes in a knoblike process; mesopræscutum about three times as long as pronotum; legs moderately long and slender; eight distal spines on hind tibiæ; meracanthi over twice as long as thickness at base; forewings subelliptical, rounded at apex, more or less maculated, subequal in length to body, nearly twice as long as wide; pterostigma large, open proximad. Abdomen slightly shorter than thorax.

Male.—Anal valve slightly longer than genital forceps, both without process. Genital segment roundly produced ventrad below level of adjacent proximal sternite.

Female.—Anal valve about as long as the rest of abdomen; ventral valve shorter than dorsal; both without process.

Type of the genus, *Haplaphalara dahli* (Rübsaamen).

The genus is very closely allied to *Aphalara* Förster, as recharacterized by Crawford ('14: 24), resembling the latter in many characters. The following characters, however, distinguish it from *Aphalara*: Longer mesopræscutum in proportion to pronotum; absence of spines on basal tarsi of hind legs; presence of pterostigma; and absence of posterior lobe on male anal valve. The last two characters, according to Crawford,

are always present in *Aphalara*. The present genus is also distinguishable from *Aphalaroida* Crawford ('14: 38) as follows: Vertex flattened and longer in proportion to width than in the latter; antennæ longer. The characters it has in common with *Aphalaroida* are as follows: Genæ somewhat roundly swollen ventrad; short frons; slight arching of thorax; lateral termination of pronotum in a knoblike swelling; thickened, semiopaque wings, with pterostigma; absence of process on male anal valve.

Haplaphalara dahli (Rübsaamen). Plate 2, fig. 16; Plate 3, fig. 23; Plate 4, fig. 41; Plate 5, fig. 51.

Aphalara dahli RÜBSAAMEN '05: 23.

Type locality.—BISMARCK ARCHIPELAGO, Coast of Rabakaul, February 27, 1897 (*Dahl*).

Male.—Length of body, 1.2 to 1.36 millimeters; width of head, 0.52 to 0.55; length of antennæ, 0.72 to 0.78; length of forewings, 1.28 to 1.3, width, 0.54 to 0.56. Brownish yellow. More or less thickly mottled with very dark brown as follows: Vertex; antennal segments I and II; distal segment of labium; thoracic nota and pleurites; hind coxæ; and abdominal tergites. Uniformly dark brown: Eyes; genital segment; genital forceps; anal valve; frons; genæ; clypeus; apical segment and distal half of subapical antennal segment; distal spines of hind tibiæ; and ungues. Pale stramineous: Sternum; trochanters; femora; tibiæ; tarsi; abdominal sternites, with exceptions noted above; and antennal segments, except as otherwise indicated above and except distal portions of IV, V, and VII, which are pale brown. Ocelli light brownish red. A uniformly dark brown, subtriangular spot occupying apical fourth of forewings; another lighter brown, broadly and irregularly linear, transverse band at middle portion; and a third subbasal, broadly linear, somewhat transverse, brown band; veins irregularly spotted with dark brown. Body and appendages finely reticulate, sparsely covered with moderately long hairs.

Head slightly narrower than thorax, very slightly declivous, dorsal surface subconfluent with pronotum. Vertex flat, about one and two-thirds times as wide as long, nearly truncate at cephalic margin, slightly rounded down in front; a shallow depression bordering anterior ocellus; caudal margin concave. Frons about one and two-thirds times as wide as anterior ocellus, visible from latter to base of clypeus; length subequal to width. Clypeus (cephalic aspect) subhemispher-

ical, with base located at about two-thirds the distance from dorsal to ventral surfaces of head. Genæ broadly swollen ventrad but not produced into genal cones. Eyes elongately subhemispherical, about two-thirds as thick as distance from margin of eye to median suture of vertex. Anterior ocellus flatly subhemispherical, subequal in diameter to antennal segment III, located mediad on anterior surface of head. Posterior ocelli subhemispherical, somewhat smaller than anterior, located near apices of angles formed by caudal and lateral margins of vertex. Antennæ about one and five-eighths times as long as width of head including eyes; segments I and II subequal in diameter, about one and two-thirds times diameter of III; the rest of the segments subequal in diameter to III; two slender apical setæ, subequal in length to apical segment, to which they are attached.

Thorax not strongly arched, about one and one-eighth times as long as wide; thickness about seven-ninths of length. Pronotum and mesopræscutum somewhat deflected cephalad but not depressed below level of adjoining sclerites; surfaces subconfluent. Pronotum about seven times as wide as long, terminating laterad slightly below level of eyes in a knoblike swelling. Mesopræscutum about two and three-fifths times as long as pronotum, about two and seven-tenths times as wide as long, irregularly subelliptical, more strongly arcuate at caudal than at cephalic margin, somewhat acutely produced laterad. Mesoscutum about one and three-tenths times as long as mesopræscutum, about two and two-fifths times as wide as long, irregularly subreniform; a short, spinelike projection from each lateral margin. Mesoscutellum about half as long as mesoscutum, about half as long as distance between points of attachment of axillary cords, truncate at cephalic margin, with a depressed, anteriorly directed projection which is confluent with surface of mesoscutum. Forewings subelliptical, slightly narrowed basad, rounded at apex; R and M+Cu subequal in length; pterostigma open proximad, slightly longer than first marginal cell; Rs, M, Cu_1 and anal margin of wing subparallel and subequidistant; first marginal cell elongate, about three times as large as second. Legs moderately long, femora about two and a half times as thick as tibiæ; eight moderately long, dark brown, distal spines on hind tibiæ; meracanthi about two and one-fourth times as long as thick, slightly deflected apicad.

Abdomen about one and one-seventh times as long as thorax, about one and one-eighth times as long as thick, about as thick

as wide. Genital segment roundly produced ventrad below level of adjacent proximal sternite. Anal valve about one-fourth as long as total length of abdomen, about twice as long as thick, rounded subapicad, and produced apicad into a short, slender, subconical projection. Genital forceps about four-fifths as long as anal valve, narrowly attenuate apicad. Anal valve, genital forceps and genital segment more thickly hairy than the rest of abdomen.

Female.—Anal valve about half the total length of abdomen, about as long as thickness at base, subacute distad, slightly flexed dorsad at apex. Ventral valve about two-thirds as long as anal, about twice as long as thickness at base, subconical, very acutely pointed distad.

Redescribed from six males and six females.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 70 meters, January, 1919. College of Agriculture accession No. 18413.

The insect lives on *Thespesia populnea* (L.) Sal. (Malvaceæ), causing irregular depressions and wrinkles in the leaf lamina. Evidence of the work and of the presence of the preadult stages is noted throughout the year in the locality cited, but the adults seem to appear only in certain months.

The occurrence of this species or of any other representative of the subfamily Liviinæ has never been recorded from the Philippines before.

Rübsaamen ('05) reports the insect as producing galls on *Thespesia macrophylla* Blume in Bismarck Archipelago.

Subfamily PAUROPSYLLINÆ Crawford

Genus **PAUROPSYLLA** Rübsaamen

Pauropsylla udei Rübsaamen ('99: 262). Plate 1, fig. 1; Plate 2, fig. 13; Plate 3, fig. 18; Plate 4, fig. 33; Plate 5, fig. 44.

Male.—Length of body, 1.76 millimeters; width of head, 0.61; length of forewings, 2.08, width, 1.23. Dark yellowish brown. Light brownish yellow as follows: Ventral half of antennal tubercles; antennal segments I, II, III, IV, and basal three-fourths of V; clypeus; coxæ; meracanthi; trochanters; femora; tibiæ, except distal spines, which are dark yellowish brown; first tarsal segments; lateral borders of mesopræscutum and mesoscutum; ventral third of mesothoracic episternum; medial half of third abdominal tergite and cephalic margin of fourth. Eyes and ocelli reddish brown. Body and appendages finely

reticulated; more conspicuously so on vertex and nota; sparsely beset with moderately long hairs.

Head subequal in width to thorax, not strongly deflected. Vertex about four times as broad as long, slightly concave at occipital margin. Frons, a narrow sclerite bounding anterior ocellus, subtriangular along anterior and posterior borders of latter. Clypeus (cephalic view) irregularly subpyriform, subconically raised on each side ectodistad, about one and one-third times as long as wide. Eyes subhemispherical, about three-fourths as thick as distance from lateral margin to median suture of vertex. Diameter of anterior ocellus about three times that of antennal segment III. Posterior ocelli slightly smaller than anterior, somewhat prominently elevated. Antennæ about one and one-third times as long as width of head including eyes; segments I and II short and thick, subequal to each other in length and diameter; III one and one-third times as long and about one-third as thick as II; the rest of the segments distad subequal in diameter to III.

Thorax about one and one-third times as long as wide, one and one-eighth times as long as thick, slightly arched. Prothorax very short, depressed below, and almost hidden by cephalic emargination of mesopræscutum. Mesopræscutum irregularly subhemispherical, about as long as wide. Mesoscutum broadly crescent-shaped with concave margin directed cephalad, about one and a half times as wide as mesopræscutum, about twice as wide as long. Mesoscutellum about half as wide as mesoscutum, about three-fifths as long as wide, slightly deflected caudad; two shallow, broadly concave indentations at cephalic margin. Forewings obovate; apex broadly rounded: M+Cu about one-fifteenth as long as R+M+Cu; first marginal cell about three times as large as second; a black, rather inconspicuous spot at anal margin between branches of cubitus; one between branches of cubitus and media; and a third between branches of media. Legs long and slender; hind leg about one and one-third times as long as fore or middle leg; ungues broadly curved.

Abdomen about four-fifths as long as head and thorax combined; slightly narrower than thorax. Genital forceps subequal in length to anal valve, elongately subovoid, about twice as long as wide. Anal valve irregularly subcylindrical, about two and a half times as long as wide. Genital forceps and anal valve more thickly beset with hairs than adjoining segments.

Female.—Genitalia about one-third total length of abdomen. Dorsal and ventral valves subequal in length and basal diameter, acutely pointed distad.

Nymphs (*apparently full-grown living specimens*).—Length of body, 2.25 millimeters; width of head, including eyes, 0.70; width of thorax, including wing pads, 1.6; length of forewing pads, 0.8, width, 0.4; length of abdomen, 1.3, width, 1.2. Dark orange yellow. Light yellow as follows: Antennæ, wing pads, and legs. Eyes dark brick-red. A slightly raised, median, dorsal ridge visible from middle of pronotum to caudal end of abdomen. Body and appendages smooth and shiny, free from waxy coating, sparsely beset with short hairs.

Head about three and a half times as wide as long, subequal in width to prothorax. Vertex rounded cephalad. Eyes moderately large, subhemispherical; caudal portion recessive into pronotum. Antennæ subequal in length to width of vertex, slender, slightly tapering toward apex.

Thorax not arched, about one and a half times as long as wide, subquadrangular at dorsum. Forewing pads about one and one-third times as long as thorax, semitranslucent, subangularly pointed ectodistad at apex. Legs stout and moderately long, sparsely pubescent; division between tibiæ and tarsal segments indistinct; ungues broadly curved.

Abdomen subcircular from dorsal aspect, very obtusely rounded caudad, shorter but wider than thorax, sparsely pubescent.

LUZON, Laguna, Los Baños Falls, near Los Baños, at an altitude of about 50 meters, January, 1917; Mount Maquiling, at altitudes of 70 to 150 meters, August, 1917. College of Agriculture accession No. 18310 (*Uichanco*).

Numerous specimens of this insect were bred from leaf galls on *Ficus variegata* Blume (Moraceæ). For descriptions of the gall, see Rübsaamen '99: 261, and Uichanco '19: 546, Pl. 6, figs. 2, 4, and 5; pl. 13, fig. 1. The causative insect was tentatively reported in the latter paper as *Pauropsylla montana* sp. nov. (MS); but a further study of the specimens before me shows that their characters are those of *P. udei* Rübsaamen. The nymphs of the present collection differ from the one figured by Rübsaamen ('99: 266, text fig. 13) in that the abdomen of the former is shorter in proportion to the body.

Rübsaamen evidently made an error in reporting the host plant as a species of Rubiaceæ. The shape of the leaf in his text figure 7, page 261, and the position, relative size, and form of the

galls, in this and in his Plate 1, figures 6 and 7, together with his descriptive notes, are apparently identical with the work of this insect as I found it on *Ficus variegata.*

Crawford ('15: 258, pl. 1, fig. F) described the insect as *P. bakeri* sp. nov., and in a later paper (Crawford '19: 145) reported its identity with Rübsaamen's species, by which the former is preoccupied.

Pauropsylla triozoptera Crawford ('13: 296). Plate 1, fig. 5; Plate 2, fig. 14; Plate 3, fig. 19; Plate 4, fig. 34; Plate 5, fig. 45.

Male.—Length of body, 1.7 millimeters; width of head, 0.64; length of antennæ, 0.96; length of forewings, 2.72, width, 1.49. Dark reddish brown. Brownish yellow as follows: Antennal segments I, II, and III, and basal fourth of IV, VI, and VII; ocelli; legs, except distal spines of femora and tibiæ and distal third of ungues, which are dark brown; genital segment; genital forceps; and anal valve. Body smooth and shiny, sparsely and briefly pubescent, more densely so at mesopræscutum, mesoscutum, mesoscutellum, femora, tibiæ, tarsi, genital segment, genital forceps, and anal valve.

Head subequal in width to thorax, not deflected. Vertex about three and one-third times as wide as long, deeply concave. Frons about four and a half times as long as wide, visible as a narrow sclerite from anterior ocellus to base of clypeus. Eyes subhemispherical, about three-fourths as thick as distance from lateral margin to median suture of vertex. Anterior ocellus subhemispherical, subequal in size to posterior. Posterior ocelli prominently elevated. Antennæ about one and a half times as long as width of head including eyes; segment I slightly thicker than II; I and II subequal in length; II about three times as thick as III; III and the rest of the segments distad subequal in diameter.

Thorax robust; length slightly shorter than thickness and about three-fourths of width. Prothorax short and completely hidden from above by cephalic portion of mesopræscutum. Mesopræscutum subpentagonal, about three-fourths as long as wide, broadly rounded down cephalad; cephalic margin describing an angle of about 90°; an abruptly subconical projection on each lateral area. Mesoscutum subreniform; concave margin directed cephalad; about two and two-fifths times as wide as long, about five-sixths as long as præscutum; a lateral, somewhat anteriorly divergent, abruptly subconical projection

on each side. Mesoscutellum about three-fourths as long as mesoscutum, about one and two-thirds times as wide as long, somewhat deflected caudad, roundly emarginate mesocephalad at cephalic margin, abruptly produced subconically ectad at anterolateral angles. Mesosternum slightly produced ventrocephalad. Wings asymmetrically obovate, hyaline; apex somewhat angular along direction of second marginal cell; pterostigma and cubital petiole wanting; first marginal cell about twice as large as second; a small, elongately subtriangular area covered with coarse brown dots between branches of cubitus, one between branches of cubitus and media, and a third between branches of media. Hind legs slightly shorter than body; fore and middle legs somewhat shorter than hind; ungues broadly curved.

Abdomen subequal in length to thorax, somewhat strongly deflected caudad, about one and a half times as long as wide, about as thick as wide. Anal valve about three-sixteenths as long as the whole of abdomen, about twice as long as diameter at base, truncately subconical, slightly constricted subdistad. Genital forceps subequal in length to anal valve, about one and a half times as long as diameter at base, vaguely retort-shaped with diameter of neck about half that of larger portion.

Female.—Dorsal and ventral valves subconcolorous with the rest of abdomen, more densely pubescent than latter. Dorsal valve narrowly subconical, acutely produced apicad, more densely pubescent than ventral, about as long as the rest of abdomen, about three and one-third times as long as diameter at base. Ventral valve slightly shorter than dorsal, about twice as long as diameter at base.

Newly emerged adults.—Bluish green. Eyes dark brown. Greenish yellow as follows: Antennal segments I and II; mesopleura and metapleura; mesosternites and metasternites; legs; and, in male, genital forceps and anal valve.

Nymph (apparently full-grown).—Length of body, 2.12 millimeters; width of head, 0.67; length of antennæ, 0.48; length of forewing pads, 0.8, width, 0.35; length of abdomen, 0.96, width, 0.9. Bluish green, lighter on head. Eyes brick red. Body and appendages covered with a white waxy coating, very sparsely beset with moderately long hairs.

Head slightly narrower than thorax, about two and a half times as wide as long, broadly rounded cephalad. Eyes subhemispherical, with caudal portions touching thorax, about three-eighths as thick as width of head. Antennæ about

three-fourths as long as width of head; segment I slightly thicker than II; II about one and one-third times as thick as III.

Thorax not arched, about one and one-fifth times as long as wide. Forewing pads about three times as long as wide, broadly rounded apicad. Hind legs about half as long as body; fore and middle legs about five-sevenths as long as hind; subdistal third of femora in all legs slightly curved entad; ungues about one and one-fourth times as long as diameter of tibiæ, strongly curved subapicad.

Abdomen about one and two-fifths times as long as thorax, about as long as wide, irregularly subcircular from dorsal aspect, slightly narrowing down caudad; caudal margin truncate, without process.

Younger nymphal instars.—Distinguishable from full-grown nymphs by their smaller size, brighter red eyes, and, in very early instars, absence of wax coating.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 42 meters, January and March, 1917. Accession No. 18309, College of Agriculture collection (*Uichanco*).

This species passes its preadult stages in the very common leaf galls on *Ficus ulmifolia* Lam. (Moraceæ). For a description of the gall and some field observations on the adult insect, see Uichanco ('19: 545, pl. 6, fig. 1; pl. 12, figs. 1, 5, and 6). The gall is apparently similar to the work of an Indian species of Psyllidæ on *Ficus glomerata* Roxb., as figured by H. M. Lefroy ('09: pl. 80, fig. 6).

Pauropsylla tuberculata Crawford ('12: 430). Plate 1, fig. 3; Plate 2, fig. 12; Plate 4, fig. 35; Plate 5, fig. 46.

Male.—Length of body, 0.9 to 1 millimeter; width of head, 0.53 to 0.64; length of antennæ, 0.35 to 0.4; length of forewings, 1.12 to 1.36, width, 0.53 to 0.6. Very dark reddish brown. A large, subtriangular, depressed, reddish orange area on metapleura. Yellowish brown as follows: Fore and middle legs; hind tibiæ and tarsi; antennæ, except distal segments, which are dark reddish brown; mesopræscutum; and distal third of anal valve. A broadly subtriangular, longitudinal, median, light reddish brown band, and a concolorous, broadly sublinear area on cephalic half of lateral margin, on mesoscutum; also on cephalic margin of mesoscutellum and median third of abdominal tergites III and IV. Body and appendages sparsely and briefly pubescent.

Head slightly wider than thorax, strongly deflected. Vertex about one and a half times as wide as long, deeply concave at occipital margin, strongly rounded down in front; a shallow, longitudinal fovea cephalad to antennal tubercle. Eyes subhemispherical, somewhat thicker dorsad than ventrad, about as thick as distance from lateral margin to median suture of vertex. Genæ somewhat swollen ventrad to antennal tubercles. Posterior ocelli subequal in diameter to anterior, slightly elevated. Antennæ a little more than half width of head, slender from segment III distad; distal segment slightly incrassate; apical setæ very slender, about half the total length of antennæ. Clypeus large and subglobose.

Thorax robust, strongly arched, about one and one-fifth times as wide as long, about one and two-fifths times as thick as wide. Pronotum about one-seventh as thick as vertex, about six times as wide as long, deflected cephalad, greater part of lateral portion concealed by eyes. Mesopræscutum about four times as long as pronotum, about two and seven-tenths times as wide as long. Mesoscutum subequal in length to mesopræscutum, about four-sevenths as long as wide. Mesoscutellum about half as long as mesoscutum, abruptly produced at anterolateral angles. Hind legs excluding coxæ about one and one-ninth times as long as body; basal tarsi with two clawlike spines distad; ungues light brown, short, broadly curved; meracanthi moderately long, about one and two-thirds times as long as diameter at base. Fore and middle legs excluding coxæ subequal in length, about one-third as long as corresponding parts of hind legs. Forewing about one and two-fifths times as long as body, narrowly obovate, about twice as long as wide, about twice as wide subdistad as subproximad, broadly rounded at apex; R one and a half times as long as M+Cu; R+M+Cu subequal in length to R; pterostigma wanting; M_{1+2} and Rs subangularly bent with corresponding vertices coalescent; first marginal cell about one-twentieth as large as second.

Abdomen about seven-tenths as long as thorax, about one and two-fifths times as thick as long, about as long as wide; third abdominal tergite greatly produced dorsad; fourth much more so. Anal valve about one-seventh as long as abdomen, about two and four-fifths times as long as thick, slightly thicker basad, truncate apicad. Genital forceps about two-thirds as long as anal valve, thicker basad, somewhat sloping distad, subacute

at apex. Anal valve and genital forceps more thickly pubescent than the rest of body.

Female.—Dorsal and ventral valves acute apicad, abruptly subconical, more densely pubescent than the rest of body. Dorsal valve about three-elevenths as long as abdomen, about one and a half times as long as thickness at base, somewhat elevated at border of anus. Ventral valve about two-thirds as long as dorsal, about as long as wide, abruptly produced apicad.

Newly emerged female.—Bright yellow. Eyes grayish white. Last apical antennal segment black. Abdomen and legs subconcolorous, lighter yellow than thorax. A white, transverse band on two or three proximal abdominal tergites.

Nymph (*age unknown; balsam mounts*).—Length of body, 1.15 millimeters; width of head, including eyes, 0.44; length of antennæ 0.4; length of forewing pads, 0.43, width, 0.22; length of abdomen, 0.56, width, 0.53. Body and appendages sparsely covered with moderately long hairs.

Head subequal in width to thorax; about one and five-sixths times as wide as long, obtusely subangular at anterior margin. Eyes subhemispherical, about one-fifth as thick as total width of head. Antennæ subequal in length to width of head, acutely pointed distad.

Thorax about as long as wide, about as wide as thick. Hind legs about one-third as long as body; femora slightly arcuate entad; ungues strongly curved. Fore and middle legs subequal in length, slightly shorter than hind, in other respects similar to hind legs. Forewing pads about twice as long as wide, about one and one-sixth times as long as thorax, roundly sloping ectodistad at base; apex subparallel to basal slope; intermediate portion subequal in width throughout.

Abdomen about as long as wide, subcircular from dorsal aspect; caudal margin rounded, without process.

LUZON, Laguna, College of Agriculture, Los Baños, at an altitude of about 50 meters. Five males and five females on pins; seven nymphs on slide; reared from leaf galls on *Alstonia scholaris* R. Br. (Apocynaceæ), May, 1917. College of Agriculture accession No. 18322 (*Uichanco*).

This species is apparently of wide distribution in the Orient. The gall caused by the insect has been described from Bismarck Archipelago by Rübsaamen ('05: 7); by Leeuwen-Reijnvaan from Java ('10: 38) and from Celebes ('16: 24); and by Uichanco from the Philippines ('19: 544, pl. 5, figs. 1 and 2; pl. 12, figs.

2 and 3). The adult (apparently female), nymph, and work, as they occurred in India, have been beautifully figured in colors by H. M. Lefroy ('09: 742, pl. 80, figs. 2–5), and the insect and its host plant casually mentioned in the text, but he evidently did not recognize it then as a new species. The first taxonomic description of this species was published by Crawford ('12) from six females bred on "pumpkin" and on *Alstonia scholaris*. The adult male and the nymphs are described for the first time in the present paper.

Genus **LEPTYNOPTERA** Crawford

Leptynoptera sulfurea Crawford ('19: 147). Plate 1, figs. 5 and 6.

Type locality.—MOLUCCAS, Amboina (*Muir*).

Leptynoptera sulfurea rubrocincta var. nov. Plate 1, fig. 4; Plate 3, fig. 20; Plate 4, fig. 38; Plate 5, fig. 48.

Male.—Length of body, 1.44 to 1.52 millimeters; width of head, 0.45 to 0.48; length of antennæ, 0.72; length of forewings, 2.05 to 2.16, width, 0.9 to 0.96. Light greenish yellow. Light brown as follows: Eyes; antennal segments I and II, and basal half of VIII; fore and middle femora; tibiæ and tarsi in all legs; an irregular, narrowly sublinear band near and parallel to caudal margin of hind coxæ; median third of abdominal sternites III and IV. Very dark reddish brown: Distal half of antennal segments IV, VI (except a proximal greenish yellow portion), distal half of VIII, and the whole of IX; the greater portion of anal valve ventrad; a broad, sublinear marking on each side of genital segment from dorsal margin to apex of its caudoventral projection; apices and distal spines of hind tibiæ; and meracanthi. Ocelli brownish yellow. Four longitudinal, narrowly sublinear, white, waxy bands on vertex from caudal margin to level of anterior ocellus and bordering foveæ; another transversely on pronotum; another linear waxy band on median area and one on each side inclosing an irregularly elliptical, sublateral area of mesopræscutum; five longitudinal waxy bands on mesoscutum, the middle one being subconfluent with the corresponding band of mesopræscutum. A subovate, bright red area bounded cephalad by a dark brown line on laterocaudal area of abdominal tergites IV to VII; a bright red, narrow, transverse band bounded cephalad by a dark brown line adjoining caudal margin of IV; a small, subcircular red spot on laterocephalic angle of abdominal sternite III. An elongately subrhomboid brown spot, intercepting a median, elongate, white band, running from

C+Sc entad and occupying about half of cell formed by C+Sc, R+M+Cu, and R; a dark brown, diffuse spot on anal vein near distal end of clavus, another near primary fork of R+M+Cu; a brown, subtriangular spot adjoining anal margin between branches of media and another between branch of media and cubitus. Body and appendages sparsely covered with rather long hairs.

Head slightly narrower than thorax, not deflected. Vertex nearly as long as wide, very slightly concave at caudal margin; cephalic margin somewhat produced laterad into a prominent, abrupt protuberance near base of antennal tubercle; lateral margins slightly raised above level of eyes; one rather deep, narrowly subelliptical, longitudinal fovea on each side of vertex between median suture and lateral margin. Genæ slightly swollen, abruptly produced cephalad beyond margin of vertex. Frons visible ventrad to anterior ocellus as an elongate sclerite, about three and a half times as long as wide, slightly narrower dorsad, rounded at dorsal end. Clypeus about one and two-thirds times as wide as frons, about one and one-fifth times as long as wide, about twice wider distad than proximad. Eyes subhemispherical, slightly thicker than distance from lateral margin to median suture of vertex. Anterior ocellus subhemispherical, not prominent. Posterior ocelli subequal in size to anterior, slightly elevated. Antennæ about one and three-fifths times as long as width of head including eyes; segments I and II subequal in thickness, three times as thick as III, both segments with ventral portions of ápex produced.

Thorax robust, not strongly arched, about as thick as long, about six-sevenths as wide as thick. Pronotum short, about one-ninth as long as vertex, about fourteen times as wide as long. Mesopræscutum about six times as long as pronotum, about one and a half times as wide as long, deflected cephalad at an angle of about 45°. Mesoscutum subequal in length to mesopræscutum, about three times as wide as long. Mesoscutellum about half as long as mesoscutum, almost truncate at cephalic margin. Forewings hyaline, costal margin subparallel to anal; apex almost truncate, rounded toward costal margin, somewhat angular toward anal; pterostigma wanting; radial sector broadly arcuate; cubital petiole wanting; cubitus not forked. Hind wings about one-fifth as long as fore, cleft from apex to near base, giving wings a biramous appearance, dark brown along costal margin and base. Hind legs excluding coxæ about five-sixths as long as body, five abrupt, rather stout spines

entad on apices of tibiæ; meracanthi short, about one and one-third times as long as thickness at base; ungues broadly curved. Fore and middle legs shorter than hind.

Abdomen about one and two-sevenths times as long as thorax, about one and four-fifths times as long as thick; thickness subequal to width. Genitalia about half as long as total length of abdomen; genital segment produced caudoventrad beyond genital forceps at an angle of 30° to 40° from median line of body; distance from apex of elongation to base of segment about three times width. Anal valve about one-sixth total length of abdomen, about one and one-third times as long as wide, somewhat attenuate and rounded apicad, abruptly petiolate basad. Genital forceps subequal in length to anal valve, about three times as long as wide, slightly thicker proximad than distad, nearly truncate at apex. Anal valve and genital forceps more densely hairy than the rest of body.

Female.—Abdomen subequal in length to thorax. Genitalia about half total length of abdomen. Dorsal valve about one and one-seventh times as long as ventral, about two and a half times as long as thickness at base, about half as thick at distal half as at basal, rounded at apex. Ventral valve about six times as long as thickness at base, acute apicad. Dorsal and ventral valves more thickly hairy than the rest of body.

Described from eleven males and nine females.

Cotypes.—No. 18348, College of Agriculture, University of the Philippines.

LUZON, Manila, Government Laboratories accession No. 5160, February 17, 1906, one male, one female, and one imperfect specimen with broken genitalia (*Banks*); Manila, Bureau of Science accession No. 14771, November 16, 1911, two specimens (*Banks*), on *Calophyllum inophyllum* L. (Guttiferæ); Laguna, Los Baños, College of Agriculture accession No. 18348, March 11, 1918, eleven males and nine females (*Uichanco*), on the same plant. The gall has been previously described (Uichanco '19: 544, pl. 13, fig. 4).

The present variety differs from the species, as originally described by Crawford, as follows: Longer vertex in proportion to width, presence of waxy bands on vertex and notum; slightly longer antennæ; absence of basal spur on hind tibiæ; longitudinal bifurcation of hind wings; red spots on the abdomen (not evident in one female of the series); and additional brown spots on forewings. The type of the species is unfortunately a single, partly mutilated example, and the differences noted

herein may have been due to the difficulty in working with an imperfect specimen. When more is known about the Moluccan insect, the present variety may finally have to be merged with the species. As the case now stands, however, there appear to be sufficient differences from Crawford's description to justify the tentative placing of the Philippine material before me in a separate variety.

In erecting the genus, Crawford ('19: 147) made some remarks regarding its being an anomalous one on account of its possessing some of the characters of both Pauropsyllinæ and Triozinæ. Supplementary to the characters he enumerated may be mentioned the caudally produced genital segment, which in combination with the reduced hind wings and other peculiarities point to a close affinity with certain members of Triozinæ, particularly *Trioza diptera* Crawford ('19: 191, pl. 3, figs. 6 and 7).

Genus **PAUROCEPHALA** Crawford

Paurocephala kleinhofiæ sp. nov. Plate 1, fig. 2; Plate 3, fig. 21; Plate 4, fig. 37; Plate 5, fig. 47.

Male.—Length of body, 0.88 to 0.96 millimeters; width of head, 0.46 to 0.48; length of antennæ, 0.26 to 0.31; length of forewings, 1.04, width, 0.48 to 0.52. Brownish yellow. Dark brown as follows: Apical and distal half of subapical segments of antennæ; eyes; median suture of vertex; junction of radial, medial, and cubital branches with marginal veins of forewings; a spot on anal vein midway between proximal and distal ends of clavus; pleura and coxæ (unevenly so); anterior, posterior, and lateral margins of abdominal tergites and lateral three-sevenths on each side of abdominal sternites, except genital segment, anal valve, and genital forceps. Light stramineous: A narrow, sublinear band bordering each side of median suture of vertex; laterocephalic tubercle of pronotum; a narrowly subtriangular, median spot from caudal to near cephalic margin of pronotum and another at mesopræscutum; posterior margin of latter; four faintly visible, longitudinal, narrowly linear markings on median third, and a diffusely subcircular area adjoining laterocephalic margin of mesoscutum; lateral third on each side of mesoscutellum near bases of axillary cords; median prominences of pseudometanotum and fourth to seventh abdominal

tergites; hind tibiæ and distal portions of hind femora (more darkly so). Body and appendages very sparsely and briefly pubescent.

Head subequal in width to thorax, somewhat deflected. Vertex about one and four-fifths times as wide as long, concave at caudal margin between posterior ocelli, broadly arcuate at cephalic margin, rounded down in front, somewhat depressed arcuately from lateral margins ventrad. Genæ slightly swollen ventrad to antennal tubercles. Eyes subglobular, about five-sixths as thick as distance from lateral margin to median suture of vertex. Clypeus subglobose, about one and a half times as thick as anterior ocellus. Anterior ocellus subhemispherical, not prominently set. Posterior ocelli subellipsoid, slightly smaller than anterior, somewhat prominently elevated due to upcurved edges of vertex. Antennæ about five-eighths as long as width of head including eyes; diameter of segments I and II subequal and about one and one-third times that of III; the rest of the segments subequal in diameter to III; two apical setæ, subequal in length to each other, and about three times as long as distal segment.

Thorax robust, not strongly arched, about eight-ninths as long as thick; width subequal to length. Pronotum about three-fourths as long as vertex, about four and a half times as wide as long; a prominent, subhemispherical tubercle on laterocephalic margin. Mesopræscutum about one and a half times as long as pronotum, about twice as wide as long, subangular laterad, abruptly deflected at lateral and caudal margins. Mesoscutum about one and two-fifths times as long as mesopræscutum, nearly twice as wide as long, broadly rounded down toward margins. Mesoscutellum about one-third as long as mesoscutum and about the same proportion to distance between points of attachment of axillary cords; anterolateral angles produced into abruptly subconical, somewhat divergent projections. Pseudometanotum produced caudad into a prominent, erect, subconical projection. Wings hyaline, irregularly obovate, broadly rounded at apex; R very slightly shorter than M+Cu; pterostigma slightly smaller than first marginal cell, subelliptical, with an inner, equally subelliptical area bounded by suture; first marginal cell subelliptical, about two and one-third times as long as wide and about twice area of second;

second marginal cell subtriangular. Hind legs longer than fore or middle; ungues broadly curved; meracanthi about three times as long as thick, of uniform thickness, rounded at apex.

Abdomen about one and one-third times as long as thick; width subequal to thickness; fourth, fifth, and sixth tergites with a prominent, erect, abruptly subconical, median tubercle; seventh with a longer and caudally directed projection at caudal margin. Anal valve about one-fourth total length of abdomen, about three times as long as thick, subcylindrical, somewhat flattened out at apex. Genital forceps about two-thirds as long as anal valve, about two and a half times as long as diameter at base, subconical.

Female.—Genitalia deflected at an angle of about 120°, anal valve about half the total length of abdomen, about twice as long as thickness at base, subconical, very acute at tip. Ventral valve about four-fifths as long as anal, about one and three-fourths times as long as diameter at base, very acutely pointed at apex, broadly curved subapically dorsad. Anal and ventral valves beset midway with irregular whorls of somewhat long, caudally divergent, bristlelike hairs.

Described from five males and nine females.

Cotypes.—No. 18415, in College of Agriculture, University of the Philippines.

LUZON, Laguna, College of Agriculture, east of "temporary building," Los Baños, at an altitude of about 50 meters, December, 1918. Accession No. 18415, College of Agriculture collection (*Uichanco*).

Nymphs and adults feed on leaves of *Kleinhofia hospita* L. (Sterculiaceæ), causing shallow, subhemispherical depressions in the leaf lamina. The insect produces no waxy secretion in any of its stages.

Paurocephala psylloptera Crawford ('13: 294).

Type locality.—LUZON, Laguna, Los Baños (*Baker*), on *Ficus ulmifolia* Lam. (Moraceæ).

Paurocephala psylloptera maculipennis var. nov. Plate 1, fig. 6; Plate 2, fig. 17; Plate 3, fig. 22; Plate 4, fig. 36; Plate 5, fig. 50.

Male.—Length of body, 1.5 millimeters; width of head, 0.65; length of forewings, 1.76, width, 0.8. Very dark fuscous. Light stramineous as follows: Ocelli; antennal segments I to III and basal half of IV; hind coxæ and trochanters; prothoracic femora and tibiæ. Brownish yellow: Mesothoracic and

metathoracic femora and tibiæ. Eyes light reddish brown. Body finely and irregularly reticulated. Body and appendages very sparsely and briefly pubescent.

Head subequal in width to thorax, slightly deflected. Vertex about four times as broad as long, conspicuously concave dorsad; caudal half hidden mediad from above by prothorax. Ocelli small, somewhat less in diameter than antennal segment III; anterior subequal in diameter to posterior. Eyes subglobose, subequal in thickness to distance from lateral margin to median suture of vertex. Antennæ about one and two-thirds times as long as width of head including eyes; diameter of segment I slightly greater than II; II about one and two-thirds times III; the rest of the segments distad subequal in diameter to III. Clypeus large and subglobose.

Thorax robust, slightly longer than wide, about as wide as thick. Length of pronotum about one-fifth that of mesopræscutum; the former deflected and partly hidden laterad beneath latter. Mesopræscutum irregularly pentagonal, about half as long as wide, produced on each side into an abrupt, caudolaterally diverging spine. Mesoscutum subequal in length to mesopræscutum; about one and one-third times as wide as long, irregularly subcircular. Mesoscutellum less than half as wide as mesoscutum, concave at cephalic margin. Metascutum with an erect, subconical epiphysis dorsad. Wing hyaline, irregularly obovate, broadly rounded at apex, slightly more than twice as long as wide. Pterostigma about one-third area of first marginal cell, brown. Hind legs slightly longer than body, about one and one-third times as long as middle legs; entire length of hind tibiæ sparsely armed with moderately long spines. Fore and middle legs subequal in length; ungues broadly curved.

Abdomen subequal in length to thorax; length about twice width, and one and one-sixth times thickness. Fifth tergite elevated dorsocaudad above level of sixth. Genital segment, together with anal valve and genital forceps, nearly one-fourth total length of abdomen, strigose. Genital forceps subellipsoidal, slightly shorter than anal valve and subequal in diameter to latter. Anal valve elongately subellipsoidal.

Female.—Genitalia about two-fifths total length of abdomen, deflected at an angle of 80° to 120° from longitudinal axis of body, very sparsely pubescent. Dorsal valve subequal in diameter to ventral; length of former about one and one-fourth times that of latter; both acutely subconical. Ventral valve broadly curved subapically dorsad.

Described from fourteen males and eight females.

Cotypes.—No. 18178, in College of Agriculture, University of the Philippines.

The present variety is distinguished from the species principally by its strongly deflected head, brown pterostigma, and darker brown abdomen, which is concolorous with notum.

Nymphs (living specimens).—Very light whitish yellow. Black as follows: Apical and subapical antennal segments; distal portions of the rest of antennal segments proximad. Eyes red. Tibiæ and tarsi reddish white. Body and appendages sparsely covered with long hairs and an irregular thin coating of wax. A slender, fluffy, waxy filament, usually longer than body, joined to each side of subapical abdominal tergite.

The species, likewise, has been reported to produce similar waxy secretions (Crawford '15: 260), and it is said to be attended by ants.

Nymph (apparently full-grown; mounted in balsam).—Length of body, 1.84 millimeters; width of head, including eyes, 0.6; length of forewing pads, 0.64, width, 0.2; length of abdomen, 1.04, width, 0.59; length of larger caudolateral wax glands, 0.2, thickness, 0.09. Light yellow. Eyes red. Brown as follows: Ungues; terminal and subterminal antennal segments. Body and appendages very sparsely covered with moderately long hairs.

Head slightly narrower than thorax, obtuse at cephalic margin. Vertex about one and one-fourth times as long as wide. Eyes subhemispherical, about four-sevenths as thick as width of vertex. Two small, irregularly diffuse areas situated mesocaudad from eyes and concolorous with latter, presumably representing posterior ocelli. Antennæ about twice as long as width of head including eyes; basal two segments shorter and thicker than the rest, as in adult.

Thorax about one and one-eighth times as long as wide, subuniform in width throughout. Hind legs about one and one-fifth times as long as middle; fore and middle legs subequal in length; ungues curved apicad.

Abdomen about one and six-sevenths times as long as thorax; width about half the length; uniform in width from thorax to beginning of caudolateral wax glands; obtusely angular caudad, terminating in a small, subcylindrical, caudal segment, about twice as wide as long and about two-sevenths as wide as larger portion of abdomen; two short, bristlelike hairs on each side of caudal segment ectodistad. Larger pair of subreniform wax

glands about twice as long as wide, nearly one-sixth as long as total length of abdomen, apparently situated on each side of fifth abdominal segment. A smaller pair, immediately caudad to and adjoining larger pair, about three-fifths as long as latter, nearly three times as long as wide, subuniform in width throughout.

LUZON, Laguna, Los Baños, at an altitude of about 50 meters, February 2, 1918, College of Agriculture accession No. 18178 (*Uichanco*). On nether surface of fully expanded young leaves of *Ficus nota* Merrill (Moraceæ).

The insects are mostly confined to an area along the midrib, and their presence is accompanied by a deposition of a white, fluffy coating of wax on the infested area of the leaf. The leaf margins are often more or less curved inferiorly.

Subfamily CARSIDARINÆ Crawford

Genus TYORIA Walker

Tyoria indica Crawford ('19: 159). Plate 1, fig. 7; Plate 3, figs. 24 and 25; Plate 4, fig. 39; Plate 5, fig. 49.

Male.—Length of body, 2.24 to 2.72 millimeters; width of head, 0.6; length of forewings, 3.2 to 3.6, width, 1.12 to 1.28. General color light clay yellow, with conspicuous, longitudinal, reddish orange streaks marking borders of foveæ on vertex and terga; distal portions of antennal segments IV to VIII, inclusive, and the whole of IX and X, dark brown. Body and appendages very sparsely and briefly pubescent.

Head slightly narrower than thorax, not deflected. Vertex somewhat broader than long, with one longitudinal fovea on each side between median suture and lateral margin. Frons visible as a narrow, elongate, subtriangular sclerite bordering anterior ocellus, subequal in width to diameter of anterior ocellus. Anterior ocellus large, reddish brown, prominent. Posterior ocelli subequal in diameter to anterior, less prominent. Eyes dull yellowish brown, subhemispherical; diameter about three-fourths length of vertex. Genæ produced cephalad into moderately large antennal sockets. Antennæ about three-fourths as long as body without wings; segments I and II subequal in length, about one-fifth as long as III; diameter of I about one and one-fourth times that of II; of II, about one and one-fourth times that of III; IV to X, inclusive, subequal in diameter to III.

Thorax not strongly arched; about two and a half times as long as wide. Pronotum two-thirds as long as vertex; with

eight ridges, conspicuous but less prominent than those bordering foveæ at vertex, arranged as follows: One bordering each lateral margin of pronotum; another parallel to and very near each of former; the last two pairs almost aligned with ridges at vertex. Three much less prominent ridges on mesoprascutum, equidistant from each other and from the lateral margins of latter. Five obsolescent, longitudinal, subequidistant ridges on mesoscutum. Legs concolorous with body; hind legs slightly longer than thorax; first and second pairs slightly shorter than third. Characteristic basal spur on hind tibia concolorous with the rest of leg. Hind tibiæ and tarsi of all legs equipped with dark brown, distal spines. Wings hyaline. Forewings about three times as long as broad; subacute at apex; R+M+Cu, cubital petiole, and media in almost one continuous straight line; R+M+Cu and cubital petiole subequal in length; area of first marginal cell about half that of second; a dark brownish tinge on terminal portions of veins; pterostigma wanting; a dark brown, acutely triangular spot between branches of media, and another between branches of media and cubitus.

Abdomen subequal in length to head and thorax combined, gradually tapering caudad. Longer pair of genital forceps about two and three-fifths times as long as anal valve, the forceps consisting of two parts: (1) a suberect, slender pair, curved cephalad near apex, about four times as long as diameter at base, abruptly pointed apicad; and (2) a shorter pair, about half as long as, and situated cephalad and parallel to, former, about four times as long as diameter at base, slightly curved cephalad, subacute apicad. Anal valve without process, about one and a half times as long as wide, somewhat constricted basad; the rest of uniform thickness. Penis drawn subhorizontally cephalad beyond anal valve to about seventh abdominal tergite; length from dorsal surface of genital segment to apex of penis about three and one-third times that of anal valve.

Female.—Dorsal and ventral valves subequal in length; both acute and tapering, forming with the genital segment a very slender, subconical projection which is slightly shorter than eighth abdominal segment. Eighth abdominal sternite beset caudad with numerous long, bristlelike hairs.

LUZON, Manila, Bureau of Government Laboratories accession No. 9931, February 11, 1909, two males and eight females on pins and two males on slides (*Banks*). MINDANAO, Kolambugan, Bureau of Science accession No. 18567, June, 1914 (*Banks*).

The specimens before me appear to differ from Crawford's original description in certain minor color characters only.

Subfamily PSYLLINÆ Puton

Genus **EPIPSYLLA** Kuwayama

Epipsylla forcipata Crawford ('17: 167). Plate 2, fig. 8; Plate 3, figs. 26 and 28; Plate 5, fig. 54.

One slightly damaged female specimen, apparently belonging to this species, collected in Manila on May 8, 1910 (*Banks*), No. 18568, Bureau of Science collection. This specimen appears to differ slightly from Crawford's type as follows: Pterostigma opaque; another proximal opaque area contiguous to pterostigma and bordering costal margin of wing. However, in as much as the specimen before me is imperfect and I have no means of deciding whether or not this is an abnormality, I deem it inadvisable to place this insect in another variety.

Genus **PSYLLA** Geoffroy

Psylla simlæ Crawford ('12: 246). Plate 2, fig. 10; Plate 3, fig. 29; Plate 4, fig. 42; Plate 5, fig. 52.

One male, two females, and a fourth specimen with broken abdomen, collected at Los Baños, Laguna, Luzon, at an altitude of about 50 meters, accession No. 18516, College of Agriculture collection, March 8, 1915 (*Banks*); from the same locality, accession No. 18517, College of Agriculture collection, February 17, 1917 (*A. Goco*). This species was formerly known only from Simla, West Himalayas, at an altitude of about 2,100 meters.

Subfamily TRIOZINÆ Puton

Genus **MEGATRIOZA** Crawford

Megatrioza banksi sp. nov. Plate 2, fig. 15; Plate 3, fig. 32; Plate 4, fig. 43; Plate 5, fig. 53.

Male.—Length of body, 3.44 millimeters; width of head, 0.64; length of antennæ, 1.4; length of forewings, 5.36, width, 1.36. General color dark yellowish brown; ventral surface of body, legs, and antennal segments III to VII lighter brown; antennal segments I and II, longitudinal ectal halves of genal cones, and ocelli red, unicolorous; vertex and notum pale yellowish brown, with lateral margins of dorsal sclerites dark brown; two dark brown, sublinear, rather broad, subparallel, longitudinal stripes extending from lateral fourth on each side of mesoscutellum to

cephalic margin of pronotum; a dark brown, very broadly linear spot bounding median suture of vertex, occupying about one-third total area of latter, and continuous thence through longitudinal ental half of genal cones. Body and appendages sparsely beset with rather long hairs; genal cones densely hirsute.

Head scarcely narrower than thorax, very slightly deflected. Vertex about one and a half times as broad as long, slightly and broadly concave mediad, broadly cleft at caudal margin. Ocelli large, subequal to each other in diameter; anterior more prominent than posterior. Eyes subhemispherical, slightly thicker than distance from lateral margin to median suture of vertex, dark brown. Genal cones porrect, long, slender, subconical, rounded apicad, noncoalescent, more densely hirsute ventrad than dorsad, about three times as long as diameter at base, slightly shorter than vertex. Antennæ about twice as long as width of head; segments III to IX slender.

Thorax robust, less than twice as long as wide, slightly arched. Pronotum about one-third as long as vertex; pronotum and cephalic two-thirds of mesopræscutum with a broadly suppressed, longitudinal, median carina which terminates cephalad in a short, horizontal, subtriangular emargination. Mesopræscutum and mesoscutum with a pair of abruptly subconical projections at lateral margins. Hind legs about twice as long as thorax; hind femora and tibiæ relatively thick; the latter somewhat hirsute, equipped with moderately large, subconical, divergent spurs basad and subdistad, and four black spines and a number of bristlelike hairs apicad; ungues broadly curved. Forewings about four times as long as wide, hyaline and membranous, with a faint brownish tinge, subacute at apex; cubital petiole and pterostigma wanting; Rs about half the length of M, the two veins subparallel; first marginal cell about one and a half times as large as second; a large, elongately subtriangular, dark reddish brown mark along anal vein between Cu_2 and base of wings; a very small, much less conspicuous, subtriangular, light brown spot between branches of cubitus, another between branches of cubitus and media, and a third between branches of media, near apex.

Abdomen subequal in length to thorax; about twice as long as wide. Genital forceps slightly longer than anal valve, both subconical, rounded apicad.

Female.—Anal and ventral valves about one-third total length of abdomen, the former slightly longer than the latter, subequal to each other in diameter, both subacute apicad, slightly

hairy; hairs on anal valve somewhat longer than those on ventral.

Described from one male and one female.

Type and allotype.—No. 18569, in Bureau of Science collection.

MINDANAO, Kolambugan, Bureau of Science accession No. 18569, June, 1914 (*Banks*). Food plant not recorded.

This species appears to be closely related to *M. armata* Crawford ('15: 264), but is distinguishable from the latter as follows: Presence of large, reddish brown spot along anal vein of forewings subbasad; genal cones slightly shorter than vertex; antennæ shorter in comparison with width of head; and pronotum much shorter than vertex.

Megatrioza pallida sp. nov. Plate 2, figs. 9 and 11; Plate 3, figs. 27, 30, and 31; Plate 4, fig. 40; Plate 5, fig. 55.

Male.—Length of body, 1.76 millimeters; width of head, 0.48; length of antennæ, 0.6; length of forewings, 2.88 to 3.04, width, 0.96. Light yellowish brown. Dark brown as follows: Two irregularly linear markings running longitudinally cephalocaudad from caudal margin of mesoscutum, near cephalic angles of mesoscutellum, to cephalic margin of mesopræscutum; marginal areas of pronotum, cephalic marginal area of mesopræscutum, and submarginal areas of abdominal tergites and sternites I to V; an irregularly diffuse spot marking each of the two foveæ at vertex; apices of genal cones; distal portions of antennal segments IV and VI, proximal and distal portions of VII, the whole of VIII, except a very small, faintly yellow, basal portion, and the whole of IX and X. Apex of genital forceps and ungues brownish black. Distal tarsal segments in all legs yellowish brown. Body and appendages very sparsely and briefly pubescent.

Head slightly narrower than thorax, somewhat declivous. Vertex about one and a half times as broad as long, cephalic emargination describing an angle of about 120°; a rather deep, angular fovea on each side extending from caudal margin to proximity of base of antennal tubercles and located midway between median suture and lateral margin of vertex. Ocelli subconcolorous with vertex: anterior ocellus moderately large, fairly prominent; posterior ocelli somewhat smaller than anterior, a large portion basad hidden beneath cuticular surface. Eyes large and prominent, dark yellowish brown, subhemispherical, about as thick as distance from lateral margin to median suture of vertex. Genal cones small, about one-fourth

as long as vertex, subporrect, slightly curved dorsad at apices. Length of antennæ about one and one-fifth times width of head; diameter of segment I about one and one-third times that of II; of II, about one and two-thirds times that of III; the rest of the segments distad subequal in diameter to III.

Thorax robust, slightly arched, about one and one-third times as long as broad. Pronotum about one-seventh as long as mesopræscutum, slightly deflected but confluent with surface of latter. Mesopræscutum about one and one-sixth times as long as wide; cephalic margin broadly angular, caudal broadly curved. Mesoscutum remotely crescent-shaped, about twice as wide as long. Cephalic margin of mesoscutellum about one-third width of mesoscutum. Wings large, hyaline, membranous, with a faint yellowish tinge, about three times as long as wide, subacute at apex; wing veins subconcolorous with body; cubital petiole and pterostigma wanting; Rs slightly shorter than M; the two veins running subparallel to each other; first marginal cell about two and a half times as large as second; a small, inconspicuous, acutely subtriangular, marginal spot, consisting of minute dark brown dots, between branches of media, another between branches of media and cubitus, and a third between branches of cubitus. Hind legs about one and one-third times as long as thorax; hind tibiæ equipped with a short basal spur and three distal, broadly curved spines. Middle legs subequal in length to thorax, slightly longer than forelegs; ungues broadly curved.

Abdomen subequal in length to thorax, about twice as long as broad. Anal valve slender, subconical, about twice as long as diameter at base, broadly curved caudad near apex. Genital forceps slightly shorter than, and subequal in basal diameter to, anal valve, less acutely pointed distad than latter, curved caudad near apex. Genital segment, genital forceps, and anal valve beset with much longer hairs than the rest of body.

Female.—Dorsal valve about two-fifths total length of abdomen, about one and two-fifths times as long as diameter at base, subconical. Ventral valve slightly shorter than dorsal, about three times as long as diameter at base; apical half about three-fifths as thick as basal. Dorsal and ventral valves more thickly beset with longer hairs than the rest of body.

Cotypes.—No. 18174, in College of Agriculture, University of the Philippines.

Nymph (earlier instar).—Length of body, 1.44 millimeters; width of head, 0.5; length of antennæ, 0.26; width of thorax, including wing pads, 1.2; length of forewing pads, 0.84, width,

0.36; length of abdomen, 0.61, width, 1. Ventral surface of body somewhat convex, dorsal almost plane. Cephalic margin of head, costal margin and apex of forewing pads, and abdomen fringed with numerous subcylindrical hairs. Hairs slightly attenuate apicad, about seven times as long as thick, semitranslucent. Basal tubercle of hair about one and one-fourth times as thick as hair, about one and a half times as long as wide; insertion of hair visible through distal third of tubercle. Surfaces of body and of wing pads less thickly covered with hairs; hairs of the same description as above.

Head about one and four-sevenths times as wide as long; cephalic margin broadly rounded, with a deep, narrow, median cleft. Eyes subhemispherical; caudal fourth partly hidden laterad by thorax; about one-sixth as thick as total width of head. Antennæ about half as long as width of head including eyes, somewhat thicker basad, slightly attenuate at apical third; a moderately long hair on apical segment distad; another subdistad.

Length of thorax apparently subequal to width.[2] Forewing pads about three times as long as wide, subacute apicad, rounded ectoproximad; intermediate portion uniform in width throughout. Hind legs about two-thirds as long as body; fore and middle legs slightly shorter than hind; ungues sharply bent over at apical third.[3]

Abdomen subequal in length to thorax, about two-thirds as long as wide, subhemidiscoidal; anal segments without process.

LUZON, Laguna, Los Baños, at an altitude of about 50 meters, January, 1918. College of Agriculture accession No. 18174 (*Uichanco*). Reared from leaf galls on *Mallotus philippensis* (Lam.) Muell.-Arg. (Euphorbiaceæ). For a description of the gall, see Uichanco '19: 546, pl. 5, fig. 3; pl. 13, figs. 2 and 3.

[2] The lateral margins of the thorax are very much obscured by the wing-pads and are almost indistinguishable in the mounted specimens.

[3] No living specimens were available at the time of writing, and on this account color notes, presence or absence of waxy coating, and such other characters as can be studied only from fresh material are not reported here. The present description is based on balsam mounts and some fragmentary field notes.

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ILLUSTRATIONS

[Unless otherwise specified, all illustrations of adult parts are based on the male.]

PLATE 1

FIG. 1. *Pauropsylla udei* Rübsaamen, forewings, female, × 29.5.
2. *Paurocephala kleinhofiæ* sp. nov., forewings, × 29.5.
3. *Pauropsylla tuberculata* Crawford, forewings, × 29.5.
4. *Leptynoptera sulfurea rubrocincta* var. nov., forewings, × 29.5.
5. *Pauropsylla triozoptera* Crawford, forewings, × 29.5.
6. *Paurocephala psylloptera maculipennis* var. nov., forewings, × 29.5.
7. *Tyoria indica* Crawford, forewings, × 29.5.

PLATE 2

FIG. 8. *Epipsylla forcipata* Crawford, forewings, × 26.2.
9. *Megatrioza pallida* sp. nov., forewings, × 26.2.
10. *Psylla simlæ* Crawford, forewings, × 26.2.
11. *Megatrioza pallida*, outlines of forewing pads, nymphs, × 56.4.
12. *Pauropsylla tuberculata*, outlines of forewing pads, nymphs, × 56.4.
13. *Pauropsylla udei*, outlines of forewing pads, nymphs, × 56.4.
14. *Pauropsylla triozoptera*, outlines of forewing pads, nymphs, × 56.4.
15. *Megatrioza banksi*, sp. nov., forewings, × 26.2.
16. *Haplaphalara dahli* (Rübsaamen) gen. nov., forewings, × 26.2.
17. *Paurocephala psylloptera maculipennis*, outlines of forewing pads, nymphs, × 56.4.

PLATE 3

FIG. 18. *Pauropsylla udei*, head, anterior aspect, × 50.8.
19. *Pauropsylla triozoptera*, head, anterior aspect, × 50.8.
20. *Leptynoptera sulfurea rubrocincta*, head, lateral aspect, × 50.8.
21. *Paurocephala kleinhofiæ*, head, anterior aspect, × 50.8.
22. *Paurocephala psylloptera maculipennis*, head, anterior aspect, × 50.8.
23. *Haplaphalara dahli*, head, dorsal aspect, × 50.8.
24. *Tyoria indica*, head, female; anterior aspect, × 50.8.
25. *Tyoria indica*, head, dorsal aspect, × 50.8.
26. *Epipsylla forcipata*, head, dorsal aspect, × 50.8.
27. *Megatrioza pallida*, antenna, nymph, × 224.
28. *Epipsylla forcipata*, head, female; lateral aspect, × 50.8.
29. *Psylla simlæ*, head, anterior aspect, × 50.8.
30. *Megatrioza pallida*, head, anterior aspect, × 50.8.
31. *Megatrioza pallida*, hair on forewing pads, nymph, × 448.
32. *Megatrioza banksi*, head, dorsal aspect, × 50.8.

PLATE 4

FIG. 33. *Pauropsylla udei*, male genitalia, × 63.5.
34. *Pauropsylla triozoptera*, male genitalia, × 63.5.
35. *Pauropsylla tuberculata*, male genitalia, × 63.5.
36. *Paurocephala psylloptera maculipennis*, male genitalia, × 63.5.
37. *Paurocephala kleinhofiæ*, male genitalia, × 63.5.
38. *Leptynoptera sulfurea rubrocincta*, male genitalia, × 63.5.
39. *Tyoria indica*, male genitalia, drawn from balsam mounts, × 63.5.
40. *Megatrioza pallida*, male genitalia, × 63.5.
41. *Haplaphalara dahli*, male genitalia, × 63.5.
42. *Psylla simlæ*, male genitalia, × 63.5.
43. *Megatrioza banksi*, male genitalia, × 63.5.

PLATE 5

FIG. 44. *Pauropsylla udei*, female genitalia, × 50.8.
45. *Pauropsylla triozoptera*, female genitalia, × 50.8.
46. *Pauropsylla tuberculata*, female genitalia, × 50.8.
47. *Paurocephala kleinhofiæ*, female genitalia, × 50.8.
48. *Leptynoptera sulfurea rubrocincta*, female genitalia, × 50.8.
49. *Tyoria indica*, female genitalia, × 50.8.
50. *Paurocephala psylloptera maculipennis*, female genitalia, × 50.8.
51. *Haplaphalara dahli*, female genitalia, × 50.8.
52. *Psylla simlæ*, female genitalia, × 50.8.
53. *Megatrioza banksi*, female genitalia, × 50.8.
54. *Epipsylla forcipata*, female genitalia, ×50.8.
55. *Megatrioza pallida*, female genitalia, × 50.8.

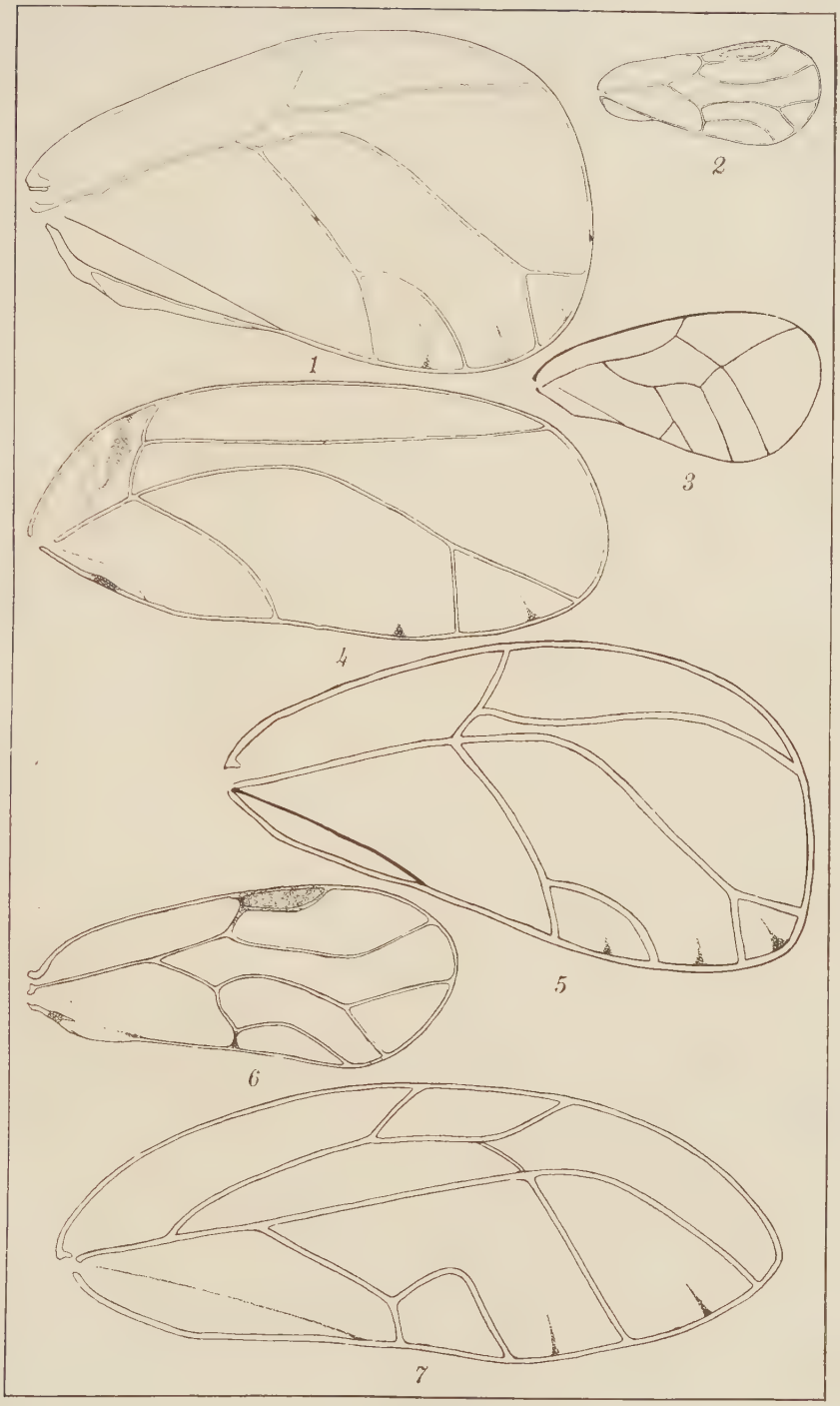

PLATE 1. PHILIPPINE PSYLLIDÆ.

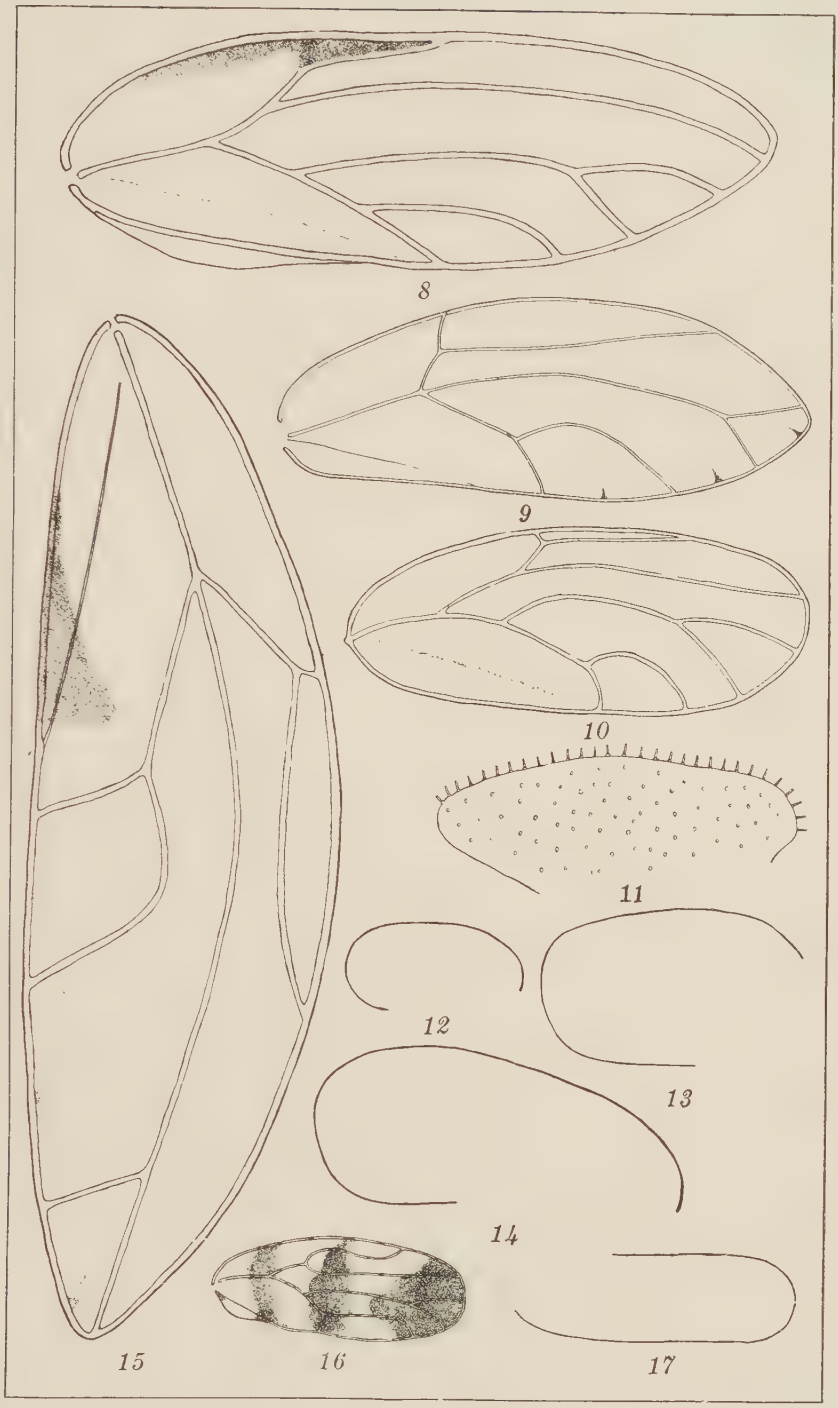

PLATE 2. PHILIPPINE PSYLLIDÆ.

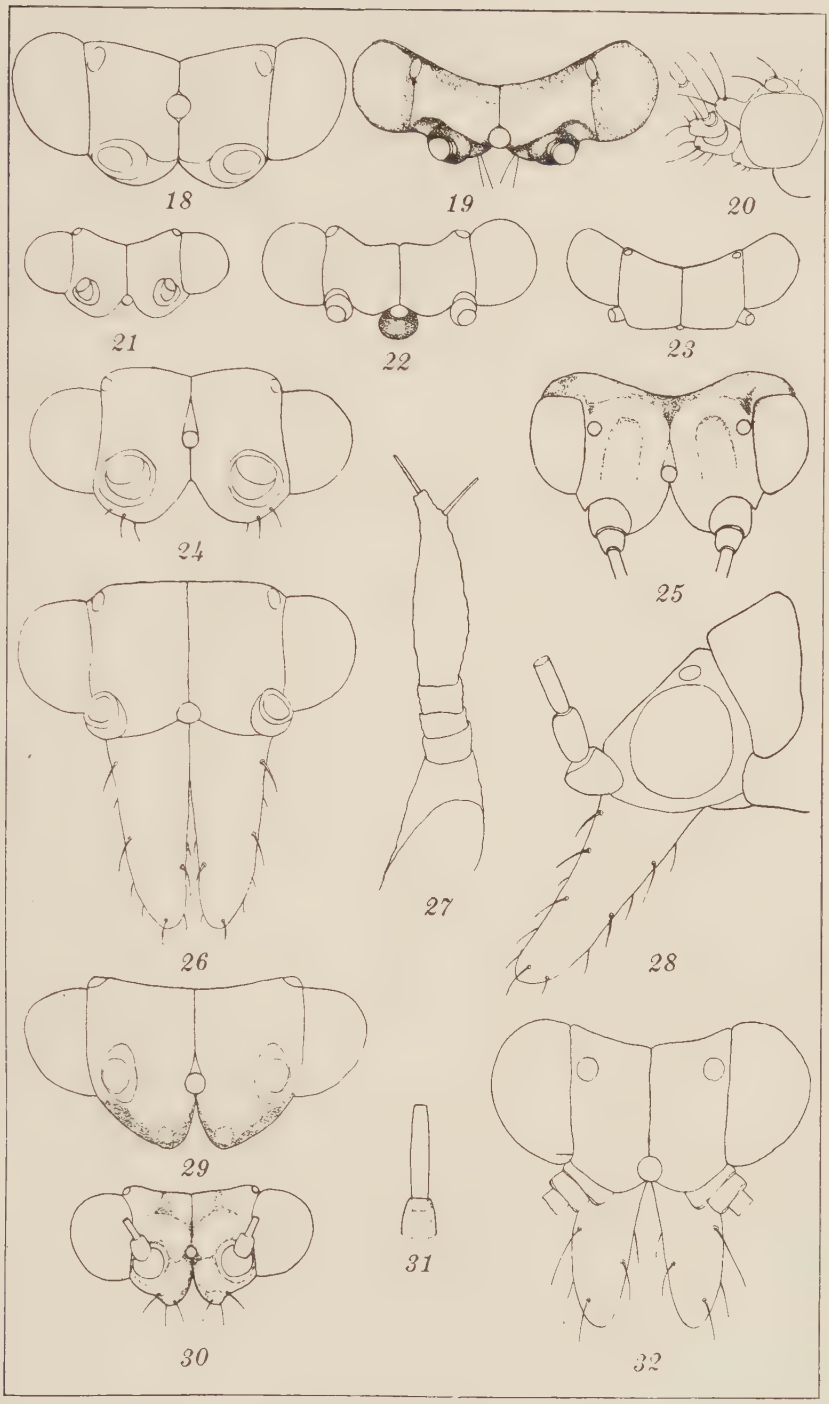

PLATE 3. PHILIPPINE PSYLLIDÆ.

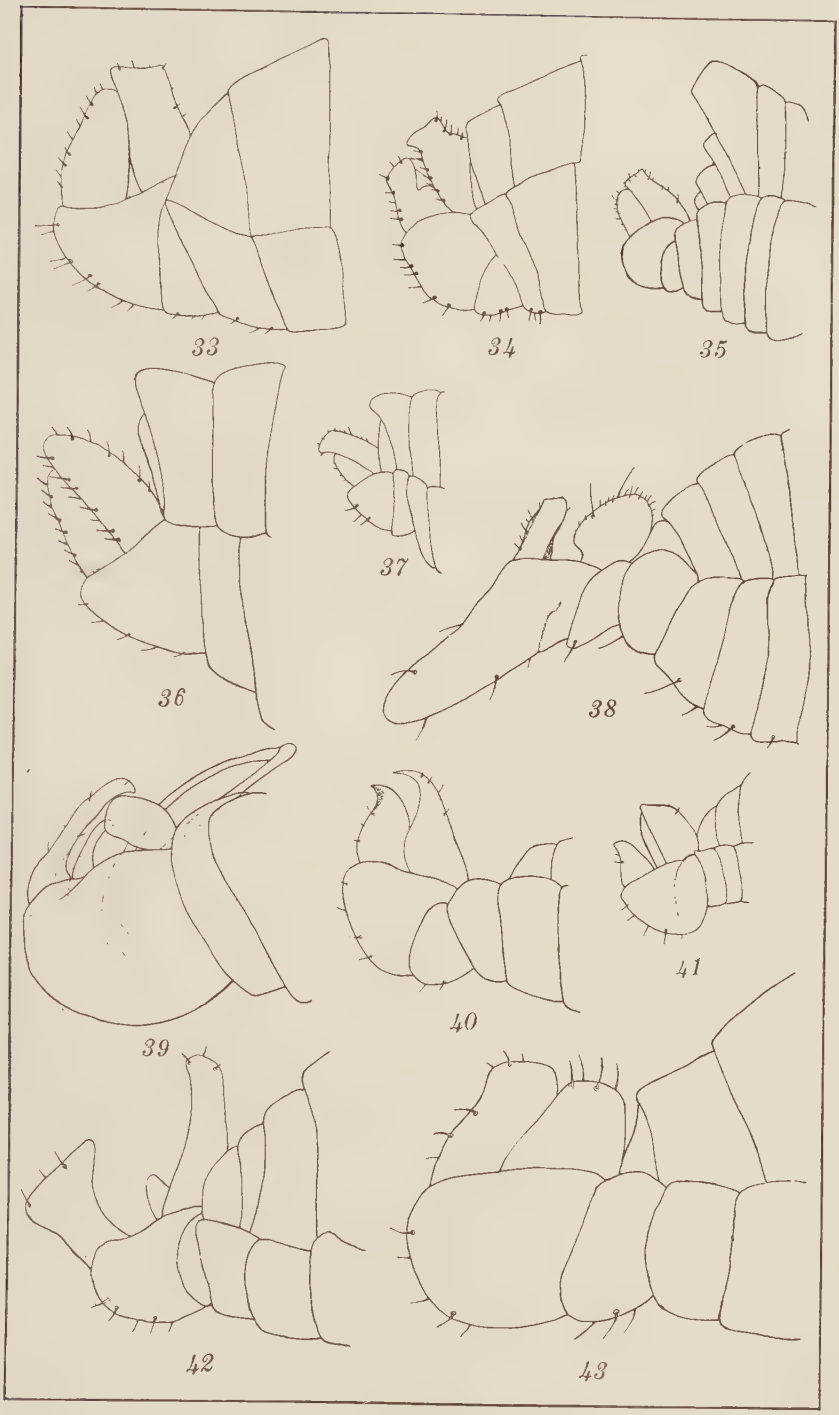

PLATE 4. PHILIPPINE PSYLLIDÆ.

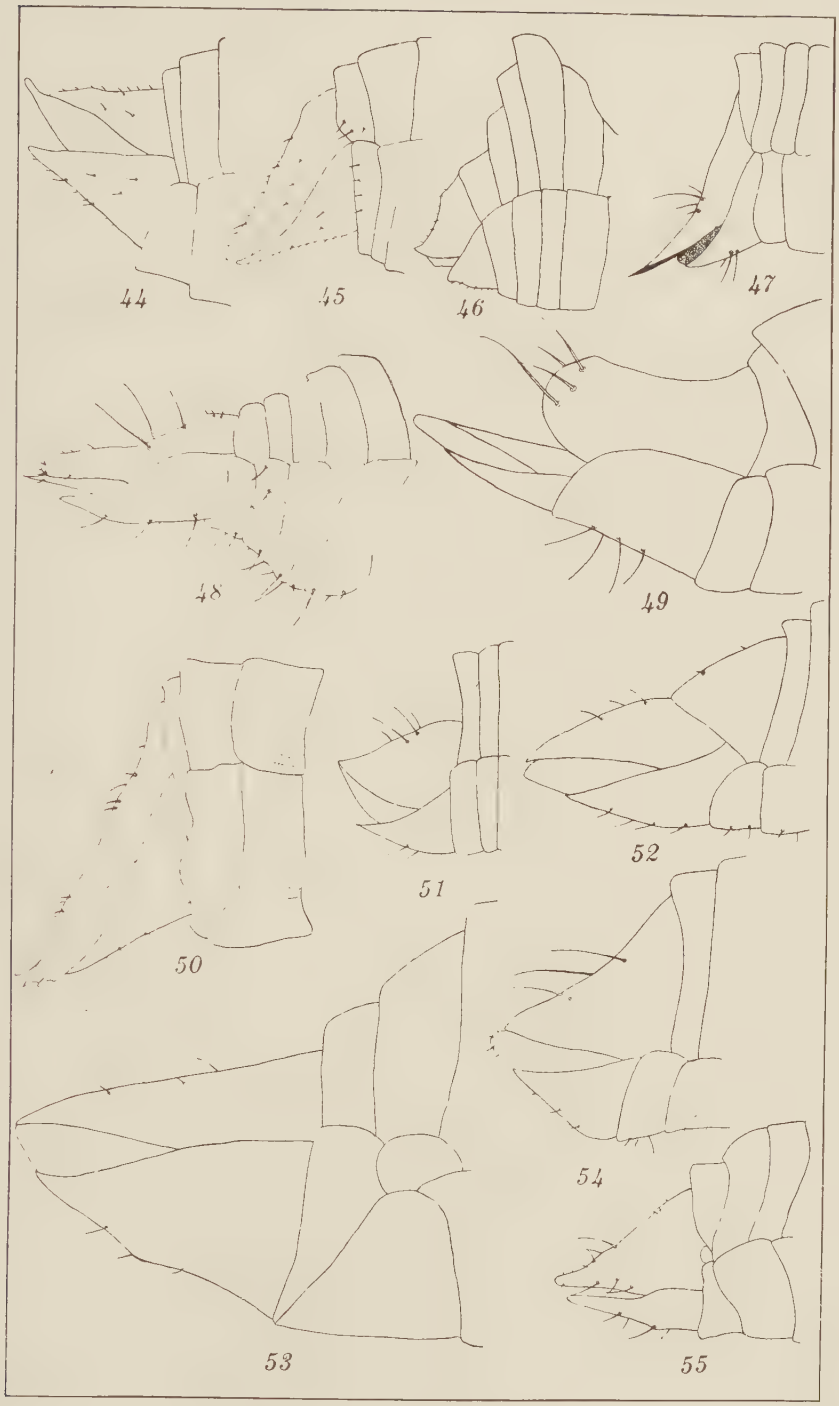

PLATE 5. PHILIPPINE PSYLLIDÆ.

NEW PHILIPPINE MYRTACEAE

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The present paper consists of the descriptions of twenty-three presumably new species; one *Decaspermum,* the remainder in the genus *Eugenia.*

DECASPERMUM Forster

DECASPERMUM MICROPHYLLUM sp. nov.

Frutex, ramulis adpresse pubescens; foliis numerosis, parvis, confertis, 8 ad 15 mm longis, ellipticis, obtusis vel acutis; floribus axillaribus, solitariis, 8 mm diameter, 2-bracteolatis, bracteolis linearis, 3 mm longis; calycis dense adpresse albido-pubescens, lobis lanceolatis, acuminatis, 2 mm longis.

A shrub, the branches glabrous, the branchlets appressed-pubescent with white hairs. Leaves numerous, crowded, coriaceous, shining, elliptic, 8 to 15 mm long, 5 to 8 mm wide, base and apex acute or rounded, the upper surface glabrous, minutely pitted; the lower surface punctate-glandular, sparingly pubescent when young, in age glabrous; petioles very short. Flowers axillary, about 8 mm in diameter, their pedicels appressed-pubescent, up to 5 mm long, 2-bracteolate at the apex, the bracteoles linear, pubescent, about 3 mm long. Calyx-tube ovoid, about 2 mm in diameter, densely appressed-pubescent with white hairs, the lobes lanceolate, acuminate, pubescent, about 2 mm long. Petals obovate, about 4 mm long, their margins slightly ciliate; when fresh white, when dry pinkish. Stamens indefinite, the filaments about 4 mm long. Ovary 5-celled, each cell 2-ovuled.

MINDANAO, Surigao Province, *Bur. Sci. 34715 Ramos & Pascasio,* June 15, 1919, in thickets along streams at low altitudes at the iron deposit along the northeast coast.

This remarkably distinct species is well characterized by its very small leaves and does not appear to be closely allied to any previously described form.

EUGENIA Linnaeus

EUGENIA SARGENTII sp. nov. § *Eueugenia.*

Arbor 5 ad 12 m alta, partibus junioribus floribusque albido-tomentosis; ramis ramulisque tenuibus, teretibus; foliis oppositis, oblongo-ellipticis ad oblongo-obovatis, usque ad 9 cm longis, in siccitate brunneis vel subolivaceis, nitidis, glandulosis, basi acutis, apice brevissime obtuseque acuminatis, nervis utrinque 8 and 10, tenuibus; floribus sessilibus, glomeratis, axillaribus et terminalibus, circiter 1 cm diametro, calycis et bracteis albido-tomentosis.

A tree, 5 to 12 m high, glabrous except the younger parts and the inflorescences. Branches and branchlets slender, brown, terete, the very young branchlets and leaves rather densely white-tomentose, soon becoming glabrous. Leaves oblong-elliptic to elliptic-obovate, coriaceous or subcoriaceous, brownish or somewhat olivaceous when dry, the lower surface somewhat paler than the upper and more or less glandular with scattered glands, shining, 5 to 9 cm long, 2 to 4 cm wide, base acute, apex very shortly and obtusely acuminate, the margins often slightly recurved; primary lateral nerves 8 to 10 on each side of the midrib, slender, indistinct, anastomosing; petioles 5 to 10 mm long. Flowers white, axillary and terminal, glomerate, sessile, about 1 cm in diameter, 4-merous, the subtending bracts oblong, obtuse, white-tomentose, somewhat navicular, about 3 mm long. Calyx-tube broad, pubescent, about 4 mm in diameter, shallow, the lobes reniform to orbicular-ovate, pubescent, glandular, rounded, about 3 mm wide, 2.5 to 3 mm long. Petals glabrous, elliptic-obovate, rounded, about 5 mm long and 4 mm wide, glandular. Stamens very numerous, the filaments 3 to 4 mm long, the staminal disk much thickened, about 3.5 mm in diameter. Fruits ovoid, fleshy, peduncled, about 1.5 cm long, black or brown when dry, nearly glabrous, when young pubescent, the peduncles 8 mm long or less.

LUZON, Cagayan Province, Peñablanca, *Adduru 169* (type), *170*, June 5, 1917, with the Ibanag names *tulisayan* and *tumaluhu*, on forested slopes at low altitudes: Zambales Province, *For. Bur. 5917 Curran*, January, 1907: Pampanga Province, Mount Arayat, *For. Bur. 17734 Curran*, March, 1910: Ilocos Norte Province, Mount Piao, *For. Bur. 13987 Merritt & Darling*, November, 1908, sterile: Rizal Province, Oriud, *Loher 5985*, February, 1906, sterile, leaves smaller than in the type. TICAO, *For. Bur. 1024 Clark*, May 30, 1914, with the Visayan name *pandaraga*.

In the section *Eueugenia* this species is well characterized among the Philippine forms by its sessile, glomerate flowers. The wood is fine-grained and hard, as in other species of the genus. The species is dedicated to Dr. C. S. Sargent, director of the Arnold Arboretum.

EUGENIA ELLIPTIFOLIA sp. nov. § *Jambosa.*

Arbor glabra, ramis ramulisque teretibus; foliis oppositis, coriaceis, nitidis, ellipticis, breviter petiolatis, usque ad 11 cm longis, apice late rotundatis, basi acutis, subtus punctatis. nervis primariis utrinque circiter 10, distinctis, anastomosantibus, reticulis vix perspicuis; inflorescentiis terminalibus axillaribusque, pedunculatis, 2- vel 3-floris; floribus breviter pedicellatis, bibracteolatis, calycis tubo infundibuliforme, circiter 8 mm longo, lobis distinctis, reniformibus.

A glabrous tree, the branches rather stout, the branchlets pale-brownish, smooth, terete, the ultimate ones about 3 mm in diameter. Leaves opposite, coriaceous, pale-olivaceous, shining, elliptic, 9 to 11 cm long, 5.5 to 7 cm wide, base acute, apex broadly rounded, smooth, the lower surface rather obscurely punctate; primary lateral nerves about 10 on each side of the midrib, distinct, somewhat curved, anastomosing directly with the subequally distinct, straight or slightly arcuate marginal nerves 2 to 3 mm from the edge of the leaf, the reticulations not prominent; petioles stout, 5 mm long or less. Inflorescences terminal and axillary, 2 to 5 cm long, peduncled, 2- or 3-flowered, or sometimes the terminal inflorescences branched from the base, the branches 1-flowered. Calyx-tube funnel-shaped, terete, smooth, blackish-brown when dry, shining, about 8 mm long and wide, the lobes 4, reniform, the pedicels 5 mm long or less.

CATANDUANES, *Bur. Sci. 30518, Ramos* (type), November, 1917, in primary forests at medium altitudes.

This species is probably as closely allied to *Eugenia calubcob* C. B. Rob. as to any other described form; it is well characterized by its elliptic leaves which are rounded at the apex and acute at the base.

EUGENIA ILOCANA sp. nov. § *Jambosa.*

Arbor circiter 18 m alta, glabra, ramis ramulisque teretibus vel ramulis leviter compressis; foliis oppositis, brevissime petiolatis, oblongis, apice obtusis ad rotundatis, basi obtusis, in siccitate pallidis, nitidis, crasse coriaceis, usque ad 7.5 cm longis, obscure parcissime puncticulatis, nervis primariis utrinque cir-

citer 15, tenuibus, adscendentibus; inflorescentiis terminalibus, paniculatis, usque ad 12 cm longis, pedunculatis vel e basi ramosis, plerumque trichotomis; floribus 5-meris, circiter 3 cm longis, in ramulis ultimis subfasciculatis, sessilibus vel brevissime pedicellatis, calycibus truncatis, obconicis.

A glabrous tree, about 18 m high, the branches and branchlets grayish-brown, terete, or the branchlets somewhat compressed. Leaves opposite, subsessile or very shortly petiolate, thickly coriaceous, oblong or narrowly oblong-elliptic, 5 to 7.5 cm long, 1.5 to 2.7 cm wide, apex obtuse to rounded, base obtuse, margins somewhat cartilaginous, pale and shining when dry, both surfaces usually sparingly and obscurely puncticulate, the glands sometimes evident only near the midrib and margins; lateral nerves about 15 on each side of the midrib, slender, not prominent, ascending, anastomosing close to the margin, the secondary ones nearly as distinct. Panicles terminal, up to 12 cm long, peduncled or branched from the base, mostly trichotomously branched, the branches and branchlets wrinkled and somewhat angular when dry, the flowers sessile or subsessile, three to five at the tip of each ultimate branchlet, the bracteoles obsolete or minute and very early deciduous. Flowers white, 5-merous, about 3 cm long in anthesis. Calyx about 14 mm long, 8 mm in diameter at the throat, terete, narrowed below, truncate or with about 5 very broad, short, obscure, irregular lobes. Petals 5, free, suborbicular, 5 to 6 mm in diameter. Stamens indefinite, their filaments 8 to 14 mm long.

LUZON, Ilocos Norte Province, Bangui, *Bur. Sci. 27420 Ramos*, March 13, 1917, at low altitudes.

A very characteristic species not closely resembling any other form known to me. It is well characterized by its thickly coriaceous, oblong to narrowly oblong-elliptic, pale, subsessile leaves with obtuse to rounded tips and obtuse bases, and, among those species with truncate calyx-tubes, its relatively large, 5-merous flowers.

EUGENIA PANAYENSIS sp. nov. § *Jambosa*.

Arbor glabra, *Eugenia speciosissimae* affinis, differt floribus brevissime pedicellatis, albis, nervis lateralibus paucioribus. Ramis ramulisque teretibus. Foliis coriaceis, oblongis ad oblongo-ovatis, sessilibus vel brevissime petiolatis, acuminatis, basi perspicue cordatis, nervis utrinque 8 vel 9, subtus valde perspicuis; floribus terminalibus et lateralibus, solitariis, brevissime pedicellatis, 4 ad 5 cm diametro.

An entirely glabrous tree, 4 to 5 m high, the branches and branchlets terete, the latter about 2 mm in diameter, grayish or somewhat reddish-brown. Leaves coriaceous, oblong to oblong-ovate, sessile or very shortly petioled, 8 to 11 cm long, 3 to 6.5 cm wide, acuminate, base rounded and conspicuously cordate, the upper surface olivaceous, slightly shining, the nerves slightly impressed, the lower surface paler than the upper; lateral nerves 8 or 9 on each side of the midrib, very prominent, distant, spreading, curved-anastomosing with the equally prominent, slightly arched, marginal nerves about 5 mm from the edge of the leaf, the reticulations lax, distinct; petioles none or very stout and up to 4 mm in length. Flowers white, solitary, 4 to 5 cm in diameter, terminal and lateral, erect, short-pedicelled. Calyx turbinate, about 1.7 cm in diameter, narrowed below, the pedicels jointed, 5 mm long or less, the lobes broadly reniform. Petals reniform, about 12 mm wide, stamens very numerous. Fruits globose, urceolate, about 2.5 cm long, 2 cm in diameter, crowned by the persistent calyx rim and lobes.

PANAY, Antique Province, Culasi, *Bur. Sci. 32470 McGregor* (type), and two specimens without number, May 24, 1918, in the mossy forest, altitude 1,000 meters.

This species is manifestly allied to *Eugenia speciosissima* C. B. Rob., of northern Luzon, from which it is distinguished by its very shortly pedicelled white flowers and fewer lateral nerves.

EUGENIA PEÑASII sp. nov. § *Jambosa.*

Arbor glabra, ramis ramulisque teretibus; foliis subcoriaceis, oblongo-ellipticis ad oblongo-obovatis, usque ad 10 cm longis, apice breviter obtuseque acuminatis, basi acuminatis, in siccitate olivaceis, supra perspicue nitidis, subtus paullo pallidioribus et distincte punctato-glandulosis, nervis primariis utrinque circiter 15, tenuibus, quam secondariis reticulisque vix magis distinctioribus; inflorescentiis axillaribus terminalibusque, circiter 6 cm longis, racemoso-paniculatis; floribus numerosis, confertis, plerumque in triadibus dispositis, sessilibus vel subsessilibus, calycis tubo circiter 12 mm longo, cylindrico, 6 mm diametro, deorsum angustato; petalis calyptratim connatis.

A glabrous tree, about 18 m high, the branches and branchlets terete, brownish, the latter 3 to 4 mm in diameter. Leaves opposite, subcoriaceous, prominently shining, oblong-elliptic to oblong-obovate, 6 to 10 cm long, 3 to 5 cm wide, the apex shortly and obtusely acuminate, base decurrent-acuminate, olivaceous

when dry, the lower surface somewhat paler than the upper and distinctly glandular-puncticulate; primary lateral nerves about 15 on each side of the midrib, slender, scarcely more prominent than are the secondary ones and the reticulations, anastomosing with the slender marginal nerves about 1 mm from the edge of the leaf; petioles 1.5 to 2 cm long. Panicles solitary in the uppermost axils and fascicled at the tips of the branchlets, about 6 cm long, subracemose, the flowers white, sessile or subsessile in triads at the tips of the ultimate branchlets, forming a rather dense corymblike inflorescence. Calyx-tube cylindric, pale when dry, about 12 mm long and 6 mm in diameter, gradually narrowed to the base, the lobes 4, shallow, about 4 mm wide and 1.5 mm long. Calyptra about 6 mm in diameter, the petals separable with difficulty, the outer ones broadly ovate, the inner obovate. Stamens indefinite; filaments 9 to 15 mm long. Style about 15 mm long.

BABUYAN ISLANDS, Calayan, *For. Bur. 26703 Peñas*, May 20, 1917, on forested slopes of Mount Nagboyoonon, altitude about 300 meters.

In vegetative characters and general appearance, this species closely approximates *Eugenia wenzelii* Merr., but is totally different in its floral structure, although the calyx-tubes are similar in both. It is distinguished at once by its 4, broad, short calyx-teeth and by its very much longer filaments.

EUGENIA SANTOSII sp. nov. § *Jambosa.*

Arbor glaberrima usque ad 18 m alta, ramis ramulisque teretibus, griseis; foliis crasse coriaceis, ovatis ad oblongo-ovatis, usque ad 8 cm longis, in siccitate utrinque pallidis, nitidis, subtus obscure glandulosis, margine perspicue revolutis, apice tenuiter caudato-acuminatis, basi longe decurrento-acuminatis, nervis utrinque tenuibus, distinctis, circiter 15; inflorescentiis terminalibus axillaribusque, pedunculatis, corymbosis, usque ad 6 cm longis, ramis ramulisque crassis, angulatis vel compressis, ramulis ultimis brevissimis, saepissime, flores 3 sessiles gerentibus; calycis tubo circiter 6 mm longo, apice circiter 4.5 mm diametro, deorsum angustato, obscurissime 4-lobato, vetustioribus plus minusve eroso; petalis liberis, circiter 3 mm diametro.

An entirely glabrous tree, 15 to 18 m high, the branches and branchlets terete, grayish or sometimes slightly brownish, nearly smooth. Leaves thickly coriaceous, pale and shining on both surfaces when dry, ovate to oblong-ovate, 6 to 8 cm long,

2.5 to 4 cm wide, the apex long and slenderly caudate-acuminate, the acumen usually curved, base long decurrent-acuminate, the margins prominently revolute, the lower surface obscurely glandular; lateral nerves about 15 on each side of the midrib, slender but rather distinct, anastomosing directly with the marginal vein about 2 mm from the edge of the leaf; petioles 1 to 1.5 cm long. Inflorescences terminal and in the upper axils, peduncled, corymbose, the rachis and branches angled or compressed, stout, the ultimate branchlets 5 mm long or less, each bearing usually three sessile flowers, the bracteoles inconspicuous. Flowers white. Calyces about 6 mm long, narrowed below, sometimes forming a short pseudostalk, the limb about 4.5 mm in diameter, very obscurely 4-lobed, in age more or less irregularly erose. Petals free, orbicular, about 3 mm in diameter, deciduous, strongly imbricate in bud. Stamens numerous, their filaments up to 7 mm in length. Fruit purple, ellipsoid or ovoid, about 6 mm long (immature).

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31844 Santos*, June 1, 1918, on slopes, altitude about 2,200 meters, with the Igorot name *bultic*.

This species is manifestly closely allied to *Eugenia robinsoniana* Elm., but among other characters is readily distinguished by its thicker leaves, which are uniformly pale and not at all brownish-purple when dry; its much stouter, angled or compressed inflorescene branches; and its strongly revolute leaf-margins.

EUGENIA SARCOCARPA sp. nov. § *Jambosa*.

Arbor glabra, ramulis circiter 5 mm diametro, distincte 4-angulatis; foliis brevissime petiolatis, oblongo-ellipticis; coriaceis, 16 ad 22 cm longis, basi leviter inaequilateralibus, rotundatis vel leviter cordatis, apice acutis vel breviter acuminatis, nervis utrinque 20 ad 25, valde perspicuis; floribus ad nodis infra foliis fasciculatis, brevissime pedicellatis, calycis tubo late infundibuliformibus circiter 6 mm longis et 7 mm latis, 4-lobatis; fructibus ovoideis carnosis, in siccitate griseis et circiter 2.5 cm diametro.

A glabrous tree, about 8 m high, the branches terete, grayish, the ultimate branchlets about 5 mm in diameter, distinctly 4-angled. Leaves opposite, coriaceous, oblong-elliptic, 16 to 22 cm long, 7 to 10 cm wide, somewhat narrowed below to the usually slightly inequilateral, rounded, or often somewhat cordate base, the apex acute or shortly acuminate, the upper sur-

face castaneous, shining, the lower paler, obscurely glandular-punctate; lateral nerves 20 to 25 on each side of the midrib, prominent, anastomosing with the equally distinct marginal nerves about 5 mm from the edge of the leaf, the reticulations not prominent; petiole very stout, 4 mm long or less. Flowers fascicled at the nodes below the branches, the calyx-tube broadly funnel-shaped, wrinkled when dry, about 6 mm long, the throat about 7 mm wide, shallowly 4-lobed, the lobes spreading, 2 mm long or less. Fruits rather large, ovoid, fleshy. when dry grayish and about 2.5 cm in diameter, crowned by the persistent calyx-tube and lobes.

LEYTE, Tacloban, *Wenzel 1484*, April 5, 1915, in forests, probably at low or medium altitudes near Tigbao.

This characteristic species does not appear to be closely allied to any previously described form. It is readily distinguishable by its vegetative characters; its 4-angled branchlets; and its shortly pedicelled flowers being fascicled at the nodes below the leaves.

EUGENIA SESSILILIMBA sp. nov. § *Jambosa.*

Arbor parva, glabra, ramis teretibus, ramulis acute 4-angulatis, internodiis sursum incrassatis, 3 ad 5 mm diametro; foliis sessilibus vel brevissime petiolatis, crassissime, coriaceis, oblongis, 8 ad 12 cm longis, basi late rotundatis, cordatis, apice acutis vel acuminatis; nervis utrinque 18 ad 20, patulis, perspicuis; floribus terminalibus, solitariis, tenuiter pedicellatis, 5 cm diametro.

A glabrous tree, about 6 m high, the older branches terete, the younger ones and the branchlets very sharply 4-angled, the ultimate internodes thickened upward and 3 to 5 mm in diameter. Leaves sessile or subsessile, opposite, very thickly coriaceous, oblong, 8 to 12 cm long, 2 to 4 cm wide, base broadly rounded and distinctly cordate, narrowed upward to the acute or somewhat acuminate apex, the margins often prominently revolute; midrib somewhat impressed on the upper surface, very stout and prominent on the lower surface; lateral nerves speading at right angles, 18 to 20 on each side of the midrib, prominent, straight, anastomosing with the equally prominent marginal nerve about 3 mm from the edge of the leaf. Flowers terminal, solitary, white, about 5 cm in diameter, the calyx-tube obconic, about 1 cm long; lobes broadly ovate, rounded, about 7 mm long and wide; pedicels slender, jointed, with the base of the calyx-tube about 2.5 cm long.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33342 Ramos,* August 20, 1918, on forested slopes, altitude about 950 meters.

In foliage characters this species closely resembles *Eugenia speciosissima* C. B. Rob., from which it is easily distinguished by its sharply 4-angled branchlets and its terminal flowers.

EUGENIA SURIGAENSIS sp. nov. § *Jambosa.*

Frutex glaber, ramis ramulisque teretibus; foliis coriaceis, oblongis ad oblongo-lanceolatis, basi late acutis ad rotundatis, sursum angustatis et leviter acuminatis, haud punctatis, nervis utrinque circiter 10, perspicuis; petiolo 2 ad 4 mm longo; floribus e ramis defoliatis, solitariis, vel pedunculis 3-floris, calycis tubo turbinato, circiter 1.5 cm longo et usque ad 2 cm diametro.

A glabrous shrub, the branches terete, grayish, rather rough, the branchlets pale brown, smooth, the ultimate ones 2 mm in diameter or less. Leaves coriaceous, oblong to oblong-lanceolate, the base broadly acute to rounded, narrowed upward to the somewhat acuminate apex, brownish or olivaceous when dry, the lower surface paler than the upper and scarcely punctate; lateral nerves about 10 on each side of the midrib, prominent, anastomosing, the reticulations lax; petioles very stout, 2 to 4 mm long. Flowers white, from the branches below the leaves, solitary or 3-flowered peduncles, the peduncles 1.5 to 2.5 cm long, the pedicels about 1.5 cm long. Calyx-tube turbinate, brown when dry, about 1.5 cm long, 1.5 to 2 cm in diameter, shallowly 4-lobed. Petals suborbicular, 1.5 mm in diameter. Fruit cup-shaped, 2.5 cm long and wide.

MINDANAO, Surigao Province, *Bur. Sci. 34686 Ramos & Pascasio,* June 14, 1919, along streams at low altitudes at the iron deposit on the northeast coast.

The alliance of this species is manifestly with *Eugenia megalantha* C. B. Rob. of Palawan, from which it differs in its fewer-nerved leaves which are not glandular-punctate and beneath, and in its shorter, very stout petioles. In *Eugenia megalantha* the leaves are subequally narrowed to both ends, but in the present species they are wider below the middle and are gradually narrowed upward.

EUGENIA TULA sp. nov § *Jambosa.*

Arbor glabra, ramulis teretibus; foliis subcoriaceis, oblongo-ellipticis ad elliptico-obovatis, utrinque concoloribus, 8 ad 11 cm

longis, basi cuneatis, apice distincte acuminatis, nitidis, minutissime nigro-punctatis, nervis utrinque circiter 7, tenuibus; inflorescentiis terminalibus axillaribusque, e basi ramosis, circiter 4 cm longis; floribus circiter 1.5 cm diametro, calycibus infundibuliformibus, 6 mm longis, 4-lobatis. Petalis suborbicularibus, 5 mm diametro, perspicue punctatis.

A glabrous tree, about 10 m high, the branches and branchlets rather slender, terete, grayish. Leaves opposite or the lower ones subalternate, subcoriaceous, oblong-elliptic to elliptic-obovate, rather grayish and of about the same color on both surfaces when dry, 8 to 11 cm long, 3 to 5 cm wide, the base cuneate, the apex distinctly acuminate, shining, the upper surface minutely pitted, the lower surface distinctly glandular with minute black or nearly black glands; lateral nerves about 7 on each side of the midrib, slender, not very prominent, arched-anastomosing, the reticulations nearly obsolete; petioles about 3 mm long. Inflorescences terminal and in the upper axils branched from the base, about 4 cm long, the lower branches usually spreading, each branch bearing 3 to 5 flowers, the ultimate branchlets 3 mm long or less. Flowers white, about 1.5 cm in diameter. Calyx funnel-shaped, 6 mm long and wide, the lobes 4, somewhat reniform, 3 to 3.5 mm long, the lower 2 mm of the calyx-tube forming a short pseudostalk. Petals suborbicular, 5 mm in diameter, densely punctate.

MINDANAO, Davao Province, Santa Cruz, *For. Bur. 27540 De Mesa,* April 29, 1919. In rich soil at low altitudes with the local Tagakaolo name *tula.*

This species is probably as closely allied to *Eugenia bordenii* Merr. as to any other described form and may be readily recognized by its minutely black-puncticulate glandular leaves.

EUGENIA XIPHOPHYLLA sp. nov. § *Jambosa.*

Arbor glabra, circiter 4 m alta, ramis ramulisque perspicue et acute 4-angulatis; foliis oppositis, lineari-lanceolatis, coriaceis, in siccitate pallidis, nitidis, usque ad 40 cm longis et 3 cm latis, utrinque subaequaliter angustatis, basi attenuatis, nervis numerosis, saltem 40 utrinque, prominentibus; inflorescentiis terminalibus, longi pedicellatis, usque ad 15 cm longis, 3-floris; floribus junioribus circiter 1.5 cm longis, alabastro obovoideo.

A glabrous tree, about 12 m high, the branches and branchlets pale, smooth, sharply 4-angled, the sides concave, more or less thickened at the nodes, 5 to 8 mm in diameter. Leaves opposite,

coriaceous, linear-lanceolate, up to 40 cm in length, 2 to 3 cm wide, pale and shining when dry, subequally narrowed at both ends, base attenuate, apex apparently acuminate, margins recurved; lateral nerves at least 40 on each side of the midrib, impressed on the upper surface, prominent beneath, somewhat spreading, slightly curved, anastomosing with the distinct submarginal nerve, reticulations obsolete on the upper surface, prominent on the lower; petioles stout, reddish-brown, rugose, about 5 mm long. Inflorescence terminal, slender, 3-flowered, long-peduncled, the inflorescences solitary or in pairs, about 15 cm long, the peduncles 10 to 12 cm long. Buds obovoid, about 1.5 cm long, rounded, narrowed below, dark-brown when dry.

MINDANAO, Lanao District, Libas, *For. Bur. 24060 Acuña*, May 29, 1916, locally known as *malasugui*.

A most striking species on account of its 4-angled stems; its very long, narrow, coriaceous leaves; and its slender, elongated, terminal, 3-flowered inflorescences. It is allied to *Eugenia ramosii* C. B. Rob., from which it is distinguished by its narrower leaves and longer peduncles.

EUGENIA ATTENUATIFOLIA sp. nov. § *Syzygium*.

Arbor glabra, circiter 10 m alta, ramis ramulisque brunneis, teretibus, vel ramulis obscure 4-angulatis; foliis coriaceis, in siccitate pallidis, nitidis, subtus punctatis, glandulis jam oculo nudo distinctis, ovato-lanceolatis, usque ad 9 cm longis, basi acutis, apice tenuiter caudato-acuminatis, nervis primariis utrinque circiter 8, tenuibus, subtus, distinctis; infructescentiis terminalibus, corymbosis, 6 ad 9 cm longis, e basi ramosis, ramulis sulcatis vel angulatis; fructibus globosis ad obovoideis, usque ad 8 mm diametro, sessilibus vel breviter pedicellatis.

A glabrous tree, about 10 m high, the branches brown or reddish-brown, striate, terete, the cortex somewhat stringy, the branchlets of the same color, smooth, usually somewhat 4-angled. Leaves opposite, coriaceous, ovate-lanceolate, pale and shining when dry, 6 to 9 cm long, 2.3 to 3 cm wide, base acute or somewhat acuminate, apex slenderly caudate-acuminate, the acumen acute, up to 2 cm in length, the lower surface distinctly punctate, the glands distinctly visible to the naked eye; primary lateral nerves about 8 on each side of the midrib, slender but distinct on the lower surface, the reticulations not prominent, anastomosing directly with the nearly straight or slightly arcuate marginal nerves 2 to 3 mm from the edge of the leaf;

petioles 5 to 8 mm long. Infructescences terminal, corymbose, branched from the base, 6 to 9 cm long, up to 7 cm wide across the nearly flat top, the branches and branchlets usually 4-angled or at least sulcate. Fruit obovoid to globose, brown when dry, smooth, up to 8 mm in diameter, sessile or jointed on very short pedicels which are in turn jointed to the usually short branchlets, usually but one or at most two on each ultimate branchlet.

CATANDUANES, Mount Mariguidon, *Bur. Sci. 30314 Ramos*, November 26, 1917, in forests near the summit of the mountain.

This species is well characterized by its prominently punctate, slenderly caudate-acuminate leaves. It belongs in the group with *Eugenia mindorensis* C. B. Rob., but differs from that species in numerous other points than those just indicated.

EUGENIA CONSANGUINEA sp. nov. § *Syzygium.*

Species *E. brittonianae* C. B. Rob. affinis, differt foliis majoribus, usque ad 12 cm longis, nervis lateralibus magis numerosis, utrinque circiter 15, floribus paullo minoribus et omnibus breviter pedicellatis.

A tree, about 8 m high, entirely glabrous, the branches and branchlets terete, brown, smooth. Leaves oblong to oblong-lanceolate, coriaceous, not punctate, 8 to 12 cm long, 2.5 to 4 cm wide, apex prominently acuminate, the acumen obtuse, base acute, the upper surface dark-brown when dry, slightly shining, the lower pale-brown; primary lateral nerves about 15 on each side of the midrib, very prominent on the lower surface, irregular, nearly straight, anastomosing with the almost equally prominent and slightly arcuate marginal nerves 2 to 3 mm from the edge of the leaf, the reticulations lax, indistinct; petioles 2 to 5 mm long. Panicles terminal, usually shortly peduncled, about 6 cm long, 6 to 8 cm wide, the lower branches up to 4.5 cm in length, the branches, branchlets, and pedicels terete or nearly so, the pedicels stout, 2 mm long or less. Flowers white, all shortly pedicelled, in triads on the ultimate branchlets. Calyx-tube turbinate, dark-brown when dry, about 4 mm long, nearly smooth, terete, narrowed below, the apex with four, very short, obscure, broad, rounded lobes. Petals united into a calyptra about 3 mm in diameter. Fruits globose, about 12 mm in diameter, smooth, dark-brown when dry, crowned by the short calyx-tube.

LUZON, Abra Province, Mount Posuey, *Bur. Sci. 26995* (type), *26984 Ramos*, February, 1917, on forested slopes and along small streams in forests at medium altitudes.

The alliance of this species is manifestly with *Eugenia brittoniana* C. B. Rob. to which it is indeed closely related. It differs in its larger, more-numerously nerved leaves, and in all of its flowers being pedicelled.

EUGENIA DIFFUSA sp. nov. § *Syzygium.*

Arbor glabra, circiter 15 m alta, ramis et ramulis teretibus, tenuibus; foliis oblongo-lanceolatis ad oblongo-obovatis, usque ad 6 cm longis, subcoriaceis, apice breviter obtuse acuminatis, basi acutis, supra subolivaceis, subtus pallidioribus, obscurissime glandulosis, nervis primariis supra obsoletis, subtus obscuris, tenuibus, densis; inflorescentiis terminalibus et in axillis superioribus, diffusis, circiter 10 cm longis, ramis ramulisque elongatis; floribus 4-meris, sessilibus, in triadibus dispositis; calycibus turbinatis, 5 mm longis; petalis calyptratis.

A glabrous tree about 15 m high, the branches and branchlets slender, terete, brown, the ultimate ones about 1.5 mm in diameter. Leaves opposite, subcoriaceous, oblong-lanceolate to oblong-obovate, 4 to 6 cm long, 1.5 to 2.3 cm wide, the apex broadly and obtusely acuminate, base acute, the upper surface subolivaceous, smooth, slightly shining, the lower paler, obscurely glandular, the midrib prominent on both surfaces; lateral nerves very slender, obscure on the lower surface, entirely obsolete on the upper surface, densely arranged, the primary ones scarcely more distinct than are the secondary ones; petioles 1 to 2 mm long. Panicles terminal and in the upper axils, about 10 cm long, lax, diffuse, the primary branches racemosely arranged, 2 to 3 cm long, the secondary ones bearing a terminal triad of sessile white flowers, the bracteoles none or very minute and caducous. Calyx-tube about 5 mm long, turbinate, pale when dry, terete, gradually narrowed below, the tip 3 to 3.5 mm wide, with four, broad, short, rounded lobes about 1.5 mm wide and 0.5 mm long. Petals wholly united into a calyptra about 3 mm in diameter. Filaments indefinite, slender, 3 to 8 mm long.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 27155 Ramos,* March 14, 1917, in dry forests at low altitudes.

This strongly marked species falls in the group with *Eugenia perpallida* Merr. and *E. parva* Merr., but is at once distinguished from both in its diffuse panicles and much larger flowers.

EUGENIA NEEI sp. nov. § *Syzygium.*

Arbor glabra, circiter 15 m alta, ramis ramulisque teretibus; foliis subcoriaceis, oblongis ad oblongo-ellipticis, usque ad 10 cm

longis, haud punctatis, apice distincte acuminatis, basi acutis vel decurrento-acuminatis, in siccitate subolivaceis, nitidis, nervis primariis utrinque circiter 20, tenuibus, distinctis, quam secundariis vix magis distinctioribus, circiter margine anastomosantibus; paniculis axillaribus, laxis, circiter 6 cm longis; floribus plerumque in triadibus dispositis, sessilibus, cylindraceis, circiter 7 mm longis, anguste clavatis, truncatis, deorsum angustatis petalis in calyptram unitis.

A glabrous tree about 15 m high, the branches and branchlets slender, terete, grayish or brownish, the former about 2 mm in diameter. Leaves opposite, subcoriaceous, oblong to oblong-elliptic, 7 to 10 cm long, 2 to 4 cm wide, subequally narrowed to the distinctly acuminate apex and the acute or decurrent-acuminate base, not punctate, the upper surface subolivaceous, shining, the lower paler; primary lateral nerves about 20 on each side of the midrib, slender but distinct on both surfaces and scarcely more prominent than are the secondary ones and the reticulations, nearly straight, somewhat ascending, anastomosing with the slender marginal vein about 1 mm from the edge of the leaf; petioles 1 to 1.5 cm long. Panicles axillary, lax, rather few-flowered, about 6 cm long, peduncled or branched from or near the base, the branches spreading or ascending, the lower ones about 3 cm long. Flowers mostly in triads at the tips of the ultimate branchlets, sometimes five on a branchlet, all sessile, ebracteolate, cylindric, the calyces about 7 mm long, brown when dry, gradually narrowed in the lower two-thirds, about 1.8 mm in diameter above, truncate. Petals united into a deciduous calyptra about 1.5 mm in diameter.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 27156 Ramos*, March 5, 1917, in dry forests at low altitudes.

This species, dedicated to Luis Née, one of the botanists of the Malaspina Expedition, belongs in the group with *Eugenia clavellata* Merr., but is entirely different in its vegetative characters as well as in its inflorescences and in its calyx-tubes not being abruptly enlarged at the tip.

EUGENIA RIZALENSIS sp. nov. § *Syzygium*.

Frutex vel arbor glabra, ramis ramulisque teretibus, ramulis ultimis tenuibus, circiter 1 mm diametro; foliis elliptico-ovatis, in siccitate pallidis, nitidis, subtus punctatis, chartaceis, usque ad 4 cm longis, basi acutis, apice obtuse acuminatis, nervis primariis utrinque circiter 12, tenuibus; infructescentiis axillari-

bus terminalibusque, brevissimis, paucifloris; fructibus ampulliformibus, circiter 8 mm longis, in siccitate atris vel atro-brunneis, basi acutis, breviter pedicellatis.

A glabrous shrub or small tree, the branches and branchlets terete, brownish to grayish, the latter very slender, about 1 mm in diameter. Leaves numerous, in general elliptic-ovate, 2 to 4 cm long, 1 to 2 mm wide, subequally narrowed to the acute base and to the obtusely acuminate apex, chartaceous, pale, of the same color on both surfaces and shining when dry, the lower surface punctate; primary lateral nerves about 12, slender, scarcely more distinct than are the secondary nerves and reticulations, anastomosing with the equally distinct marginal nerve about 1 mm from the edge of the leaf; petioles 2 to 3 mm long. Infructescences terminal and axillary, excluding the fruits 5 mm long or less, depauperate-cymose. Fruits apparently dark-purple when fresh, when dry ampulliform, about 8 mm long, black or very dark-brown, 3 to 4 mm in diameter in the middle, narrowed to the acute base, smooth or slightly wrinkled, again narrowed above the middle, the apex truncate.

LUZON, Rizal Province, Mount Susong Dalaga, *Bur. Sci. 29280 Ramos & Edaño,* August 2, 1917, on the forested upper ridges.

This species is well characterized by its small leaves; its very slender branchlets; its very short, cymose, terminal and axillary infructescences, and its ampulliform fruits. It belongs in the group with *Eugenia claviflora* Roxb.

EUGENIA SIDEROCOLA sp. nov. § *Syzygium.*

Frutex vel arbor parva, glabra, ramulis 4-angulatis, tenuibus; foliis coriaceis, anguste oblongis ad oblongo-ellipticis, obtusis vel rotundatis, basi cuneatis, 2 ad 4 cm longis, 8 ad 14 mm latis, haud punctatis, nervis lateralibus obsoletis; inflorescentiis terminalibus, pedunculatis, usque ad 4 cm longis, multifloris, ramulis ultimis dichotomis vel trichotomis, floribus sessilibus, calycis 2 ad 2.5 mm longis.

A glabrous shrub or small tree, up to 4 m high, the branches grayish brown, terete, the branchlets somewhat 4-angled, slender. Leaves coriaceous, narrowly oblong to oblong-elliptic, the apex obtuse or rounded, base cuneate, 2 to 4 cm long, 8 to 14 mm wide, the lower surface scarcely punctate, the lateral nerves and reticulations obsolete; petioles 1 to 2.5 mm long. Inflorescences terminal and in the uppermost axils, peduncled, 2.5 to 4 cm long, many-flowered, the ultimate branchlets dichotomous

or trichotomous. Flowers sessile, the calyx shallowly toothed, wrinkled when dry, reddish brown, 2 to 2.5 mm long, the petals suborbicular, 2 mm in diameter, more or less calyptrate.

MINDANAO, Surigao Province, *Bur. Sci. 34521* (type), *34722 Ramos & Pascasio*, June 14, 1919, on ridges and along streams at the iron deposit on the northeast coast, extending from low altitudes to at least 650 meters.

This species is well characterized by its small, coriaceous, nerveless leaves and, although in some respects suggestive of *Eugenia cagayanensis* Merr., it differs radically from the latter in its inflorescences and flowers, and is not closely allied to it.

EUGENIA BERNARDOI sp. nov.

Arbor glabra, circiter 5 m alta, ramis ramulisque teretibus; foliis oppositis, ovatis ad lanceolatis, basi latissime rotundatis et perspicue cordatis, brevissime petiolatis vel subsessilibus, sursum angustatis, tenuiter acuminatis, usque ad 13 cm longis, coriaceis, nitidis, in siccitate olivaceis, epunctatis, nervis primariis utrinque circiter 15, haud prominulis; infructescentiis terminalibus, sessilibus vel breviter pedunculatis, cymosis, rhachibus et ramis circiter 3 cm longis; fructibus ovoideis, in siccitate pallidis, circiter 2.5 cm longis.

A small glabrous tree, about 5 m high, the branches and branchlets slender, terete, about 2 mm in diameter, smooth, reddish-brown, the younger parts often with somewhat shredded cortex. Leaves coriaceous, epunctate, ovate to lanceolate, opposite, very shortly petioled or subsessile, 9 to 13 cm long, 2.5 to 5.5 cm wide across the base which is broadly rounded and rather prominently cordate, gradually narrowed upward from near the base to the slenderly acuminate apex, when dry olivaceous, shining; lateral nerves slender, not prominent, rather irregular, about 15 on each side of the midrib, anastomosing with the subequally prominent continuous marginal nerve about 1.5 mm from the edge of the leaf; petioles 2 mm long or less. Infructescence terminal, cymose, excluding the rather large fruits about 3 cm long, sessile or shortly peduncled. Fruits pink when fresh, when dry pale, ovoid, about 2.5 cm long, the pericarp thin, coarsely wrinkled, the persistent calyx lobes 4, subreniform, about 3 mm wide.

LUZON, Cagayan Province, Aparri, *For. Bur. 27074 Bernardo*, October 16, 1917, in dense forests, altitude about 15 meters, with the local name *maramaatan*.

This very characteristic species probably belongs in the group with *Eugenia zeylanica* Wight. It is conspicuously characterized by its nearly sessile, broadly rounded, and distinctly cordate leaves, which are gradually narrowed upward from near the base to the slenderly acuminate apex, the leaves varying in outline from ovate to lanceolate. It is totally different from all the other known Philippine species of this very large genus.

EUGENIA CAPIZENSIS sp. nov.

Arbor glabra, circiter 10 m alta, ramulis teretibus, circiter 3 mm diametro; foliis subcoriaceis, nitidis, vix punctatis, oblongis, 18 ad 34 cm longis, basi rotundatis et leviter cordatis, apice acutis vel leviter acuminatis, nervis utrinque circiter 25, valde perspicuis; petiolo circiter 5 mm longo; infructescentiis longipedunculatis partibus floriferis 5 ad 6 cm longis, ramis inferioribus usque ad 3 cm longis; calycis urceolatis, 1 ad 1.5 cm longis, circiter 7 mm diametro, truncatis, limbo valde producto.

A tree about 10 m high, the branches terete, the ultimate ones somewhat compressed, grayish or reddish brown, about 3 mm in diameter. Leaves subcoriaceous, shining, scarcely punctate, oblong, 18 to 34 cm long, 7.5 to 11 cm wide, the base rounded and slightly cordate, the apex acute to somewhat acuminate; lateral nerves about 25 on each side of the midrib, prominent, straight, anastomosing with the equally prominent marginal nerves 4 to 6 mm from the edge of the leaf. Petioles stout, about 5 mm long. Infructescences long-peduncled, the peduncles up to 18 cm in length, the flower-bearing portions 5 to 6 cm long and wide, the lower branches up to 3 cm in length. Calyx after anthesis urceolate, 1 to 1.5 cm long, about 7 mm in diameter, truncate, the limb extended 5 to 7 mm above the ovary.

PANAY, Capiz Province, Mount Salibongbong, Bur. Sci. *35584 Martelino & Edaño*, June 22, 1919, on forested slopes, altitude about 500 meters.

The alliance of this species is apparently with *Eugenia urdanetensis* Elm. and *E. caudatifolia* Merr. It differs from the former in its much larger leaves and flowers and its elongated peduncles, and from the latter in its less-acuminate, fewer-nerved leaves and apparently larger flowers.

EUGENIA CARDIOPHYLLA sp. nov.

Arbor parva, glabra, ramis ramulisque teretibus, crassis, circiter 5 mm diametro. Foliis oppositis, crasse coriaceis, brevis-

sime petiolatis, ovatis ad late ovatis usque ad 14 cm longis, basi latissime rotundatis et leviter cordatis apice breviter acuminatis, in siccitate pallidis, utrinque concoloribus, nitidis, eglandulosis; nervis primariis utrinque circiter 15, distinctis, cum lateralibus conjunctis; inflorescentiis terminalibus, corymboso-paniculatis, 5 ad 8 cm longis, sessilibus, basi ramosis, ramis ramulisque crassis, brevibus; fructibus sessilibus, ad apices ramulorum confertis, leviter urceolatis, junioribus circiter 7 mm longis.

A glabrous tree, about 4 m high, the branches and branchlets terete, rather stout, about 5 mm in diameter, brownish, nearly smooth when dry. Leaves ovate to broadly ovate, thickly coriaceous, eglandular, 10 to 14 cm long, 6 to 9 cm wide, rather pale, shining and of the same color on both surfaces when dry, the base very broadly rounded and slightly cordate, apex shortly acuminate; lateral nerves about 15 on each side of the midrib, about equally distinct on both surfaces, nearly straight, spreading, anastomosing with the equally distinct marginal nerves 3 to 5 mm from the edge of the leaf, the reticulations very obscure; petioles stout, reddish-brown, 2 mm long or less. Inflorescences terminal, stout, 5 to 8 cm long, sessile, branched from the base, corymbose-paniculate, the branches stout, the primary ones 2.5 to 3.5 cm long, brown, rugose, about 4 mm in diameter, the ultimate branchlets usually in threes, about 1 cm long, stout, compressed, the flowers all sessile and crowded at the tips of the branchlets, three to nine on each branchlet. Young fruits somewhat urceolate, cylindric, slightly wrinkled when dry, about 7 mm long, crowned by the four short calyx-lobes.

MINDANAO, Bukidnon Subprovince, Malantog, *For Bur. 26534 Rola,* April 17, 1917, in the margins of forests, altitude about 600 meters.

This species does not appear to be very closely allied to any previously described Philippine form. It is well characterized by its thickly coriaceous, subsessile, heart-shaped leaves, and its stout, terminal inflorescences, the sessile flowers being crowded on the ultimate branchlets.

EUGENIA MARTELINOII sp. nov.

Arbor parva, glabra, ramulis teretibus, 2 ad 3 mm diametro; foliis sessilibus, coriaceis, supra nitidissimis, oblongis ad oblongo-ellipticis, subtus minute punctatis, 6 ad 10 cm longis, apice obtusis vel late acuminatis, basi late rotundatis et distincte cordatis,

nervis utrinque circiter 18, tenuibus; infructescentiis terminalibus, basi ramosis, 3 ad 4.5 cm longis, floribus sessilibus, calycis urceolatis, circiter 1.5 cm longis, limbo producto 5 ad 8 mm longo, leviter 4-lobato.

A small glabrous tree, the branches and branchlets terete, the latter 2 to 3 mm in diameter. Leaves sessile, oblong to oblong-elliptic, coriaceous, the upper surface strongly shining, the lower surface rather dull and minutely punctate, 6 to 10 cm long, 3 to 5 cm wide, the apex obtuse or broadly and obtusely acuminate, the base broadly rounded and distinctly cordate; lateral nerves slender, about 18 on each side of the midrib, straight, anastomosing with the equally distinct marginal nerves 1 to 2 mm from the edge of the leaf. Infructescences terminal, branched from the base, 3 to 4.5 cm long, the branches rather stout, 4-angled, flowers sessile, the calyx after anthesis urceolate, about 1.5 cm long, the throat about 8 mm in diameter, the limb produced 5 to 8 mm, shallowly 4-lobed.

PANAY, Capiz Province, Mount Salibongbong, *Bur. Sci. 35630 Martelino & Edaño,* June 19, 1919, in forests at the summit of the mountain, altitude about 650 meters.

A species well characterized by its terete branchlets; its sessile, cordate, strongly shining leaves; its terminal inflorescences; and its elongated calyx-tubes. The rim of the calyx-tube is extended above the ovary for a distance of from 5 to 8 mm. This species does not appear to be closely allied to any previously described form, although in some respects an alliance with *Eugenia ilocana* Merr. is indicated.

EUGENIA PASCASIOII sp. nov.

Frutex glaber, ramulis tenuibus, teretibus; foliis coriaceis, oblongis ad oblongo-lanceolatis, 12 ad 16 cm longis, basi acutis, apice caudato-acuminatis, nitidis, haud punctatis, nervis utrinque circiter 15, indistinctis, reticulis obscuris vel obsoletis; inflorescentiis terminalibus, breviter pedunculatis, 4 cm longis, ramulis brevibus, ad nodis valde constrictis, calycis tubo oblongo, 7 ad 8 mm longo, 3.5 mm diametro, subtruncato.

A glabrous shrub, the branchlets rather slender, terete. Leaves coriaceous, oblong to oblong-lanceolate, 12 to 16 cm long, 3 to 4.5 cm wide, the base acute, the apex slenderly caudate-acuminate, the upper surface dark olivaceous, shining, the lower paler, not glandular-punctate; lateral nerves slender, indistinct,

about 15 on each side of the midrib, anastomosing with the equally indistinct marginal nerves 2 to 3 mm from the edge of the leaf, the reticulations obscure or obsolete; petioles 7 to 10 mm long. Inflorescences terminal, shortly peduncled, about 4 cm long, the few branches and the branchlets greatly constricted at the nodes, 4 to 8 mm in length, the pedicels very short. Calyx-tube oblong, brown when dry, 7 to 8 mm long, about 3.5 mm in diameter, truncate or obscurely toothed, narrowed below to the blunt base.

BUCAS GRANDE, *Bur. Sci. 35057 Ramos & Pascasio,* June 11, 1919, in dry forests at low altitudes.

The alliance of this characteristic species is not entirely clear although in some respects it is suggestive of *Eugenia dura* Merr.; it is, however, very distinct from that species.

DESCRIPTIONS OF NEW PHILIPPINE WASPS OF THE SUBFAMILY PSENINÆ

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The present paper is based on material in the collection of the United States National Museum, and on that forwarded to the author by C. F. Baker from Los Baños, Philippine Islands. The types of all the new species and most of the specimens are in the National Museum.

Genus **DIODONTUS** Curtis

The scope of the genus *Diodontus* is here enlarged to include species which belong to the group *Psenulus* Kohl and new species which differ in both thoracic and venational characters from typical members of the genus. Many of the species from the Philippine Islands differ from typical members of the genus in having the first recurrent interstitial with or antefurcal to the first intercubitus. One of the new species, *Diodontus scutatus,* differs from all other members of the genus known to the author, in having the parapsidal furrows strong and complete. At first sight these two groups seem to be worthy of generic rank, but there is some variation in the position occupied by the first recurrent, and in some species the parapsidal furrows are present anteriorly. For this reason, and because it seems likely that more collecting, in this and other tropical regions, will reveal still other specific aggregates showing diversity in structure, it has been deemed advisable to enlarge, rather than restrict, the generic, concept. By this, however, the author does not wish to be understood that he would imply that the Philippine species are closely allied to the Nearctic species. It is his belief that future investigations will demonstrate the desirability of naming, at least as subgenera, such specific groups.[1]

[1] For a discussion of the genotype of *Diodontus* see Proc. U. S. Nat. Mus. 49 (1915) 243.

Key to the Philippine species of Diodontus Curtis.

1. Abdomen black or with reddish spots only on second tergite..... 2.
   Abdomen reddish except sometimes the petiole..... 4.
2. Scutellum yellow; no tubercles on frons near the top of the eyes; four anterior femora yellow..... D. xanthognathus (Rohwer).
   Scutellum black; a prominent tubercle on frons near the top of the eyes; four anterior femora black except the apices..... 3.
3. Posterior surface of propodeum rugulose; pronotum and metanotum marked with yellow..... D. tuberculifrons sp. nov.
   Posterior surface of propodeum coarsely reticulate; pronotum and metanotum black..... D. maurus sp. nov.
4. Parapsidal furrows strong, extending to scutellum; petiole black. D. scutatus sp. nov.
   Parapsidal furrows weak, wanting posteriorly..... 5.
5. Thorax except tubercles black..... 6.
   Thorax largely yellow..... 7.
6. Petiole concolorous with gaster; area outside lateral ocelli depressed. D. philippinensis sp. nov.
   Petiole black; area around ocelli not depressed.... D. basilanensis sp. nov.
7. Frons, near the top of the eye, with a low tubercle; scutum with large punctures..... D. bakeri sp. nov.
   Frons without tubercles; scutum practically impunctate..... 8.
8. Face with a transverse ridge just below antennæ; large species. D. ajax sp. nov.
   Face without a transverse ridge..... 9.
9. Apical margin of clypeus slightly produced and emarginate so as to appear bidentate; scutum mostly yellow; first recurrent and first intercubitus interstitial..... D. luzonensis sp. nov.
   Apical margin of clypeus truncate, not bidentate; scutum largely black; first recurrent interstitial..... 10.
10. Frons shining, with a few aciculations; first recurrent in the first cubital; flagellum much thickened apically..... D. luteopictus sp. nov.
    Frons subopaque, coriaceous; first recurrent in the second cubital; flagellum not much thickened apically..... D. multipictus sp. nov.

A. Parapsidal furrows complete to scutellum.

Diodontus scutatus sp. nov.

In the complete parapsidal furrows and the venation of the anterior wings, this species differs from the typical members of this genus.

Female.—Length, 7 millimeters. Clypeus flat, shining, sparsely punctured basally, the apical margin straight, with three small median teeth and a small lateral tooth; face opaque, finely granular; a median, free-edged, truncate process above the middle of the face connecting with the lower .margin of the very prominent ventral portion of the frontal carina; frons, vertex, and posterior orbits smooth, shining; no tubercles on the frons; a broad, shallow U-shaped depression partially surrounding the ocellar area; ocelli in an equilateral

triangle; the postocellar line subequal to the ocellocular line; scape of normal length, the outer margin slightly curved; flagellum subclavate, the first joint one-sixth longer than the second; thorax smooth, shining; pronotum rounded, not carinate, the lateral angles rounded; parapsidal furrows strong, complete to scutellum, parallel for most of their length; propodeal enclosure nearly transverse, with many rugæ; posterior surface of the propodeum with a strong median sulcus of uniform width; sides and dorsal aspect of propodeum separated by a curved, finely crenulate furrow; abdomen smooth, shining; postpetiole not sharply defined; petiole cylindrical; strongly curved basally, extending slightly beyond the middle of the posterior femur; posterior femur slightly produced at the base beneath; posterior tibia sharply thickening apically, at the base with a number of short close spines; longer calcarium of the posterior tibia strongly curved, subequal in length to the posterior basitarsus; first and third cubital cells each receiving a recurrent vein, the first near the apex, the second at the basal third; second cubital cell trapezoidal in outline; third intercubitus oblique; venation of hind wings normal. Head black; mandibles except apices and palpi, yellow; scape yellow; flagellum ferruginous, the apical joints piceous; thorax yellow; pronotum anteriorly, a median spot on the scutum, inclosure and median sulcus of propodeum, mesepimeron, a line beneath wings, and a small spot at apex of propodeum black; legs yellow, the posterior femora and tibiæ ferruginous; abdomen, except the black petiole, red. Wings hyaline, iridescent; venation yellowish. Face, clypeus, sides of frons, and posterior orbits with silvery pubescence, thorax with sparse gray hair.

Male.—Length, 7 millimeters. Clypeus slightly convex, the apical margin rounded with two minute median teeth; facial prominence broader than in female, extending the width of the face; posterior orbits very narrow, broader below; scape short, straight; flagellum moniliform; posterior surface of propodeum obliquely rugulose, the median sulcus feebly foveolate; posterior femur and tibia normal. Black; mandibles except apices, palpi, scape, posterior margin of pronotum, tubercles, tegulæ, anterior margin of the scutum and a projection posteriorly above wings, a median quadrate posterior spot on the scutum, prepectus, spot below wings, scutellum, metanotum, propodeum except a transverse basal and apical spot and median sulcus yellow; flagellum piceous, the basal segments ferruginous beneath.

Except where mentioned the male agrees with the female.

Type locality.—Los Baños, Laguna, Luzon. Described from one female type and one male allotype from Los Baños and from a female paratype from Mount Maquiling. All received from C. F. Baker.

Type.—Catalogue No. 22838, United States National Museum.

A single male from Puerto Princesa, Palawan, received from C. F. Baker after the above was written, differs from the allotype in lacking some of the yellow markings. It is labeled as variety A and is not considered as part of the type material. The color of this specimen is as follows: Black; mandibles, except apices, scape, dorsal margin of pronotum, tubercles, tegulæ, a spot above and one below, scutellum, metanotum, two small, elongate spots on posterior surface of propodeum yellow; flagellum piceous, yellow below; legs yellow, bases of four anterior femora brownish, hind legs below trochanters brownish; abdomen reddish, petiole and postpetiole black; wings hyaline, venation pale brown.

B. Parapsidal furrows wanting, or at most only present anteriorly.

1. Second and third cubital cells each receiving a recurrent, or the first recurrent interstitial with the first intercubitus.

a. Abdomen and most of body black.

Diodontus xanthognathus (Rohwer).

Males and females of this species were taken at Los Baños and on Mount Maquiling, Luzon, and at Puerto Princesa, Palawan; a male was taken at Dapitan, Mindanao. All received from C. F. Baker.

Female.—Length, 6 millimeters. Facial carina almost obsolete; median teeth of clypeus more distinct than in male; antennæ subclavate, the third joint slightly longer than the fourth; posterior surface of propodeum smooth shining, median sulcus poorly defined; pygidial area not defined; posterior tarsi piceous; second tergite with two reddish spots which vary in size. Otherwise agrees well with male.

There is some variation in the color of the four anterior femora, as in two males they are piceous to near the apex.

b. Abdomen reddish, thorax yellow marked with black.

Diodontus bakeri sp. nov.

This species may be separated from *Psenulus interstitialis* Cameron by the triangular, not transverse, inclosed area on the propodeum, and by the different clypeus.

Female.—Length, 9 millimeters. Clypeus flat, closely, finely punctured, the apical margin with two triangular median teeth; face sculptured like the clypeus, without a transverse carina; frontal carina complete from anterior ocellus, very prominent between the antennæ; frons, vertex, and posterior orbits shining; on the frons near the top of the eye margin is an elongate tubercle, the dorsal margin of which is tangent to a line touching the lower margin of anterior ocellus; postocellar line one-fourth shorter than the ocellocular line; scape nearly straight; flagellum thickening apically, the third joint distinctly longer than the second; anterior margin of the pronotum feebly carinate, the lateral angles rounded; mesoscutum with sparse, rather large punctures; parapsidal furrows weak, about one-third the length of the scutum; scutellum and metanotum impunctate; mesopleura and sides of propodeum anteriorly shining, impunctate; inclosed area of propodeum broadly triangular, with strong longitudinal carinæ, defined posteriorly by a smooth area; posterior surface and sides of propodeum posteriorly finely transversely striate-reticulate, the posterior surface with a median sulcus; abdomen smooth, shining; postpetiole rather sharply defined anteriorly; petiole cylindrical, curved, as long as posterior leg to apical third of femur; pygidial area not defined; venation typical except that the first recurrent is interstitial with the first intercubitus; second cubital cell trapezoidal in outline; third intercubitus sharply angulate above the middle. Head black; mandibles, except apices, yellow; scape and pedicellum yellow, flagellum piceous, ferruginous beneath; thorax yellow; pronotum anteriorly, three spots on the scutum (the median one the largest), mesosternum medially, spot on mesepisternum, posterior margin of mesepisternum, mesepimeron, metapleura, inclosed area and median sulcus of propodeum black; legs yellow, posterior trochanters, bases of posterior femora and posterior tarsi piceous; abdomen reddish. Wings hyaline, iridescent; venation dark brown. Face, clypeus, and thorax with sparse golden pubescence.

Type locality.—Mount Maquiling, Laguna, Luzon. Described from one female from Mount Maquiling (type) and one female from Los Baños, Luzon. Collected by C. F. Baker, for whom the species is named.

Type.—Catalogue No. 22839, United States National Museum.

Diodontus luzonensis sp. nov.

This species closely resembles *Diodontus bakeri* but may be easily differentiated from that species by the impunctate scutum

and the absence of tubercles on frons near the top of inner eye margin.

Female.—Length, 8 millimeters. Clypeus gently convex, the surface finely punctured; apical margin with two obscure median teeth; face sculptured like the clypeus, without a transverse carina; a strong, blunt, ridgelike tubercle between bases of antennæ; frontal carina weak but complete; frons, vertex, and posterior orbits smooth, shining; postocellar line slightly shorter than ocellocular line; scape gently curved; antennæ subclavate; third joint one-third longer than fourth; pronotum subcarinate anteriorly, the lateral angles rounded; mesoscutum, scutellum, metanotum, and mesepisternum smooth, shining; parapsidal furrows weak, about one-third the length of scutum; inclosed area of propodeum broadly triangular, longitudinally rugose; posterior surface and sides of propodeum finely obliquely rugulose; posterior surface with a median sulcus; abdomen smooth, shining; postpetiole nodose; petiole curved, cylindrical, and as long as the posterior legs to near apices of femur; pygidial area obsolete; venation typical, except for the interstitial first recurrent and first intercubitus; second cubital cell trapezoidal; third intercubitus strongly angulate above middle. Head black; mandibles, except apices, and palpi yellow; scape and pedicellum yellow, flagellum piceous, ferruginous beneath; thorax yellow; a median spot on scutum, a small spot before tubercle, a spot below each tegula, mesepimeron, a spot before, inclosed area of propodeum and sulcus of posterior surface black; legs yellow, the posterior pair red below trochanters; abdomen red. Wings hyaline, iridescent; venation dark brown. Face, clypeus, inner margins of eyes to vertex and posterior orbits with dense, silvery or slightly yellowish pubescence; thorax with sparse, gray hair.

In the paratype there is a small black spot on the side of the mesoscutum.

Type locality.—Los Baños, Laguna, Luzon. Described from two females forwarded by C. F. Baker.

Type.—Catalogue No. 22840, United States National Museum.

Diodontus multipictus sp. nov.

Allied to *Diodontus luteopictus*, but can be distinguished by the characters used in the preceding key.

Female.—Length, 8.5 millimeters. Clypeus flat, the apical margin narrowly depressed and truncate; face without a transverse carina; frontal carina strong, especially prominent

below; frons and vertex coriaceous with a tendency to rugulosity just above the antennæ; occiput smooth; lateral ocelli in distinct pits; postocellar line distinctly shorter than the ocellocular line; antennæ rater short, scarcely thickening apically, the third joint distinctly longer than the fourth; anterior dorsal margin of pronotum carinate, not dentate laterally; scutum polished, with well-separated punctures, parapsidal furrows not indicated; scutellum and metanotum with only setigerous punctures; base of propodeum with a triangularly shaped, depressed area which is crossed by about twelve rugæ; the median sulcus distinct, deep; posterior surface of the propodeum coriaceous; mesepisternum polished, with only setigerous punctures, sutures not foveolate; petiole cylindrical, curved, almost as long as hind trochanter and femur; longer calcarium of hind tibia shorter than hind basitarsus; first recurrent received by the second cubital near the base; second recurrent received well within the third cubital cell. Black, with abundant yellow marks; flagellum testaceous; mandibles, scape, pronotum dorsally, tubercles, tegulæ, large spot on mesepisternum, spot below hind wings, scutum except three broad lines, scutellum, metanotum, propodeum except basal depressed area and median line yellow; legs yellow, hind femora, tibiæ, and tarsi testaceous; petiole yellow at base, black apically; gaster reddish; body sparsely clothed with silvery hair; wings clear hyaline; venation testaceous.

Type locality.—Mount Banahao, Luzon. Described from one female received from C. F. Baker.

Type.—Catalogue No. 22841, United States National Museum.

2. First and third cubital cells each receiving a recurrent vein.

c. Body almost entirely black.

Diodontus tuberculifrons sp. nov.

Female.—Length, 8.5 millimeters. Clypeus flat, with separate, distinct punctures, the apical margin straight, with two median teeth; face sculptured like the clypeus; facial protuberance nearly as wide as face, rounded laterally and emarginate medially where the strong frontal carina joins it; frontal carina from anterior ocellus to between bases of antennæ weak; frons, vertex, and posterior orbits smooth, shining, very sparsely punctured; intraocellar area strongly raised, punctures distinct; ocelli in an equilateral triangle, postocellar line subequal with the ocellocular line; on the frons opposite the top of the eye is an elongate convex tubercle; scape rather short, the outer

margin slightly curved; flagellum stout, subclavate, the first joint slightly longer than the second; pronotum carinate anteriorly, rounded laterally; mesoscutum shining, with sparse, poorly defined punctures which are smaller and denser anteriorly; parapsidal furrows weak, indicated for about half the length of the scutum; scutellum and metanotum with separate distinct punctures; mesopleura, metapleura, and sides of propodeum anteriorly, smooth, shining; episternauli poorly defined; inclosed area of propodeum broadly triangular, with a few rugæ, the median ones more prominent; posterior surface of propodeum transversely rugulose, the sides posteriorly finely reticulate; legs robust; longer calcarium of posterior tibia nearly as long as hind basitarsus; abdomen smooth, shining; petiole cylindrical, curved, about the same length as the hind femur; pygidial area defined by carinæ, very long and narrow, the carinæ nearly parallel; first and third cubital cells each receiving a recurrent vein; second cubital cell narrower above because of the oblique first intercubitus; venation of hind wings normal. Black; mandibles except apices, palpi, scape, flagellum beneath except apices, pronotum posteriorly, tubercles, tegulæ, two spots on scutum posteriorly, metanotum, four anterior legs below apical third of femora, posterior femora beneath apically, posterior tibiæ except a black median band and posterior basitarsi yellow; face and clypeus with silvery pubescence; vertex and thorax with sparse hair. Wings hyaline, iridescent; venation black.

The paratypes indicate that the line on the metanotum may be interrupted.

Type locality.—Los Baños, Laguna, Luzon. Described from two females (one type) from Los Baños, and from one female from Mount Banahao. All specimens received from C. F. Baker.

Type.—Catalogue No. 22842, United States National Museum.

Diodontus maurus sp. nov.

This species is allied to *Diodontus tuberculifrons* Rohwer, but besides the characters given in the preceding key it may be distinguished from that species by the black hind legs.

Male.—Length, 7 millimeters. Clypeus convex medially, the apical margin with two obtuse teeth, which are separated by a U-shaped emargination; clypeus and face with distinct, separate punctures; frontal carina weak dorsally, very prominent between bases of antennæ to the transverse facial carina; transverse facial carina nearly complete to eye margins where it joins a raised

line which follows the eye margins; frons and vertex shining and sparsely punctured; on the frons near the top of the eye is an elongate, shining tubercle; intraocellar area and behind a narrow curved depressed line; postocellar line slightly longer than the ocellocular line; antennæ submoniliform, the third joint slightly longer than the fourth; anterior dorsal margin of the pronotum carinate and feebly dentate laterally; scutum shining, with well-separated, distinct punctures; parapsidal furrows present anteriorly; scutellum and metanotum punctured like the scutum; propodeum coarsely reticulate, the median impressed line of uniform width; mesopleura shining, almost impunctate, the sutures feebly foveolate; longer calcarium of the posterior tibia shorter than the hind basitarsus; petiole cylindrical, fully as long as hind trochanter and femur; abdomen shining; first recurrent joining first cubital well before the apex. Black; mandibles except apices, spot on tubercles, scape beneath, and four anterior tibiæ and tarsi yellow; rather sparsely clothed with silvery hair; wings hyaline, iridescent; venation black.

Type locality.—Mount Maquiling, Laguna, Luzon. Described from one male received from C. F. Baker.

Type.—Catalogue No. 22843, United States National Museum.

d. Abdomen reddish, thorax black without yellow markings.

Diodontus philippinensis sp. nov.

Judging from the description this species resembles *Psen rufiventris* Cameron, but may be separated from that species by the different sculpture on the front, different propodeum, and shorter petiole.

Female.—Length, 8 millimeters. Clypeus convex, the apical margin truncate, the surface irregularly punctured; face finely punctured; a strong carina, between the bases of antennæ, extends ventrally until it unites with the complete transverse facial carina, and dorsally to the anterior ocellus (not so prominent above the antennæ); frons, vertex, and posterior orbits smooth, shining; between ocelli and eye an elongate raised area; postocellar line slightly shorter than the ocellocular line; antennæ slightly thickening apically, scape curved, the third joint slightly longer than the fourth; pronotum carinate anteriorly, anterior lateral angles sharp; mesoscutum with sparse, small punctures; parapsidal furrows weak, extending about half the length of the scutum; mesepisternum smooth, shining; scutellum sculptured like the scutum; inclosed area on propodeum broadly triangular, sharply defined posteriorly by a carina and with longitudinal rugæ; sides and posterior surface reticulate, posterior surface

with a median carina; postpetiole not nodose; petiole cylindrical, as long as the posterior leg to apex of femur; abdomen smooth, shining; pygidial area obsolete; first recurrent received near apex of first cubital cell; second cubital cell narrowed above; second recurrent received in the third cubital cell at a little greater distance from the second transverse cubitus than the first recurrent is from the first transverse cubitus; venation of hind wings typical. Black; mandibles except apices, first three segments of flagellum, tegulæ, tubercles yellow; legs and abdomen reddish; flagellum piceous, yellowish beneath; face, clypeus, and thorax (more sparsely) clothed with silvery pubescence. Wings hyaline, iridescent; venation brown.

Type locality.—Los Baños, Laguna, Luzon. Described from two females (one type) forwarded by C. F. Baker. A paratype from Lamao, Bataan, Luzon, also from C. V. Piper.

Type.—Catalogue No. 22844, United States National Museum.

In the position of the first recurrent this species is not typical of the genus *Diodontus*.

Diodontus basilanensis sp. nov.

Allied to *Diodontus philippinensis*, but can be readily separated by the characters given in the preceding key.

Female.—Length, 8 millimeters. Clypeus convex, the apical margin with a depressed area medially which is nearly truncate; frontal carina strong, terminating ventrally in a transverse ridge; seen from in front this ridge is slightly produced, and then emarginate, medially; antennæ long, slender, but slightly thicker apically, the third joint about one-fifth longer than the fourth; frons flat; no depression around the ocelli; postocellar line only a little longer than ocellocular line; anterior dorsal margin of pronotum with a distinct carina, not dentate laterally; scutum shining, with only setigerous punctures, parapsidal furrows present on anterior half; scutellum shining, almost without sculpture; metanotum with dense hair; base of propodeum with a depressed area which is crossed by about twelve rugæ; rest of propodeum, except polished areas at the sides basally, reticulate-coriaceous, the reticulations more pronounced posteriorly; mesepisternum smooth, with setigerous punctures, the sulci not foveolate; four anterior femora rather robust; longer calcarium of hind tibia subequal in length to the hind basitarsus; petiole cylindrical, strongly curved, its length about equal to that of the hind femur; first recurrent slightly before the first intercubitus; second recurrent joining the third cubital at a distance

half the length of the second intercubitus from its base. Black; mandibles, scape, flagellum beneath, tegulæ, tubercles, and legs beyond coxæ testaceous; gaster reddish; head and thorax with long silvery hair which is especially dense on the propodeum; wings hyaline, iridescent; venation testaceous.

Type locality.—Basilan. One female from C. F. Baker.

Type.—Catalogue No. 22845, United States National Museum.

e. Abdomen reddish, thorax black with yellow markings.

Diodontus luteopictus sp. nov.

Of the described oriental species this species seems to be more closely allied to *Psen pulcherrimus* Bingham, but the color, sculpture, and venation are decidedly different from that species.

Female.—Length, 9.5 millimeters. Clypeus very slightly convex, shining, sparsely punctured, the apical margin rounded; face more closely punctured than the clypeus; a strong median carina, between the bases of the antennæ, ends well above the middle of the face, as a short transverse carina, and extends dorsally to the anterior ocellus; frons, vertex, and posterior orbits smooth and shining; intraocellar area raised; ocelli in an equilateral triangle, the anterior ocellus the largest; postocellar line subequal to the ocellocular line; scape short, straight; flagellum subclavate, first joint one-fourth longer than second, the second and third subequal; pronotum carinate anteriorly, rounded laterally; scutum with sparse, poorly defined punctures; parapsidal furrows weak, indicated on the anterior fourth; scutellum, metanotum, mesosternum, mesopleura, metapleura, and sides of propodeum anteriorly smooth, shining, impunctate; inclosed area of the propodeum broadly triangular, prolonged as a sulcus to the apex of the segment, the basal portion with a few prominent rugæ; posterior surface and sides of propodeum posteriorly transversely rugulose; abdomen smooth, shining; postpetiole not sharply defined; petiole cylindrical, slightly longer than the posterior legs to apices of femora; pygidial area not defined; first and third cubital cells each receiving a recurrent vein; second cubital cell nearly quadrate; third intercubitus strongly curved; venation of the hind wings normal. Black; mandibles except apices, palpi, scape, pedicellum, flagellum beneath, pronotum posteriorly, tubercles, tegulæ, a line above, two spots below, two spots on scutum (broader behind), scutellum, postcutellum, spot beneath each posterior wing, posterior surface of propodeum except a median line, legs except the posterior femora above and beneath, and the posterior tarsi

yellow; abdomen ferruginous, except petiole and spots on the third and fourth tergites and sternites which are piceous. Wings hyaline, iridescent; venation pale brown. Face, clypeus, frons, and thorax (sparsely) with yellowish pubescence.

Type locality.—Luzon. Described from two females from C. F. Baker. The type from Mount Maquiling, the paratype from Mount Limay.

Type.—Catalogue No. 22849, United States National Museum.

The venation of the anterior wings is not typical of this genus.

Diodontus ajax sp. nov.

The large size and transverse ridge across the face will readily distinguish this species from its allies.

Female.—Length, 12 millimeters. Labrum broadly arcuately emarginate apically and with a fringe of hair; clypeus convex, with separate, distinct punctures, the apical margin with two small teeth; frontal carina prominent and sharp, terminating ventrally in a transverse ridge which does not quite reach the eye margin; frons and vertex shining, with small sparse punctures; no tubercles on frons; ocelli in a low triangle; the postocellar line subequal with the ocellocular line; flagellum only slightly thickened apically, the first joint somewhat longer than the second; pronotum sharply carinate anteriorly but not toothed; scutum shining, with small, well-separated punctures, parapsidal furrows present anteriorly; scutum in front of scutellum strongly foveolate; scutellum and metanotum smooth, impunctate; mesopleura smooth, polished, the posterior aspect finely aciculate, dorsal aspect with a transverse area which has twelve longitudinal carinæ; median sulcus of posterior surface strong and of uniform width; legs rather hairy; longer spur of hind tibia as long as the basitarsus, strongly angled basad of middle; petiole cylindrical, without carinæ, nearly as long as hind trochanter and femur; abdomen polished; first recurrent before the first intercubitus by a distance as great as the second abscissa of radius, the second recurrent the same distance beyond the second intercubitus; third intercubitus forming a right angle with the cubitus for a short distance only, then strongcurving inward to the radius so that the third cubital is one-fourth longer on the cubitus. Head black; a yellow spot on mandibles; antennæ black, scape, pedicellum, and most of flagellum beneath yellowish; thorax black with the following yellow marks: Top of pronotum, tegulæ, scutum except a large median and a small lateral spot, scutellum, metanotum, two large

spots on posterior and lateral surfaces of propodeum, top of mesepisternum; legs yellow, posterior femora and tibiæ above black; hind tarsi brownish; abdomen reddish, base of petiole yellow, its apex blackish; wings hyaline, iridescent; venation dark brown.

Type locality.—Mount Maquiling, Laguna, Luzon. Described from one female received from C. F. Baker.

Type.—Catalogue No. 22847, United States National Museum.

Genus PSEN Latreille

The three Philippine species of Pseninæ, which have the nervellus reclivate and postfurcal, belong to the subgenus *Mimesa* Schuckard and may be distinguished by the following synopsis:

1. Propodeal enclosure with a deep, narrow median sulcus; legs blow coxæ rufous..... P. politiventris sp. nov.
   Propodeal enclosure without a distinct median sulcus..... 2.
2. Face and clypeus with silvery pubescence; legs and abdomen black. P. melanosoma sp. nov.
   Face and clypeus with golden pubescence; anterior legs below coxæ, and posterior legs in part yellowish ferruginous; abdomen with ferruginous spots..... P. aureohirta sp. nov.

Psen (Mimesa) politiventris sp. nov.

Besides the characters used in the above synopsis, this species can be readily distinguished from the other Philippine species by the highly polished abdomen.

Female.—Length, 8.5 millimeters. Apical margin of clypeus broadly produced, the sides of the produced portion rounded, medially, with a broad V-shaped emargination; face with rather close, small punctures; a faint carina between bases of antennæ; frons and vertex smooth, shining, though medially the frons is punctate-striate; ocelli in a low triangle, the postocellar line subequal with the ocellocular line; antennæ rather long, thickened apically, the third joint much longer than the fourth; pronotum short, the anterior dorsal margin carinate, not prominent laterally; scutum subglabrous, with small, separate, distinct punctures; parapsidal furrows slightly indicated anteriorly; scutellum polished, with rather large, distinct, well-separated punctures; metanotum impunctate; propodeal inclosure concave, U-shaped in outline, with a narrow median sulcus and about twelve oblique rugæ; posterior surface of the propodeum reticulate; the median sulcus foveolate; mesepisternum shining, practically without sculpture; episternum distinct; sides of propodeum shining, with small well-separated punctures; petiole cylindrical, as long as hind leg to apex of femur; gaster

polished; pygidium sharply defined, two and one-half times as long as basal width, granular; second recurrent interstitial with the second intercubitus. Black; legs below coxæ rufous (tarsi somewhat infuscated); wings smoky, venation black; face with dense, slightly golden, pubescence; thorax with sparse silvery pubescence.

Type locality.—Baguio, Benguet, Luzon. Described from a single female received from C. F. Baker under his No. 7993.

Type.—Catalogue No. 22881, United States National Museum.

Psen (Mimesa) melanosoma sp. nov.

Male.—Length, 9 millimeters. Clypeus convex, with close small punctures, the apical margin slightly rounded and with two rounded median teeth; face sculptured with transverse carina; frontal carina complete from anterior ocellus to between bases of antennæ where it is more prominent; frons with distinct, small, close punctures; vertex (more broadly laterally) and posterior orbits shining; ocelli in a low triangle; the postocellar and ocellocular lines subequal; scape rather short, the outer margin nearly straight; flagellum rather long, slightly thickening apically, first joint one-third longer than second, the fifth and sixth joints irregularly rounded beneath; pronotum feebly carinate anteriorly, rounded laterally; parapsidal furrows completely wanting; scutum shining, with close, well-defined punctures; scutellum convex, more sparsely punctured than the scutum; mesopleura and metapleura shining, impunctate; episternauli complete; inclosed area of propodeum broadly triangular in outline, closely rugose, medially with a diamond-shaped area; sides and posterior surface of propodeum coarsely reticulate, the posterior surface with a median carina; legs slender; abdomen shining impunctate; petiole cylindrical, as long as posterior leg to apex of femur; last tergite with sparse punctures; second cubital cell large, trapezoidal in outline, third transverse cubitus strongly bent at middle. Black; anterior legs below femora piceous; clypeus, face, frons below middle, and pronotum dorsally with appressed silvery pubescence; thorax with sparse silvery pubescence except on the scutum where it is blackish. Wings hyaline, iridescent; venation black.

Type locality.—Mount Maquiling, Laguna, Luzon. Described from two males (one type) received from C. F. Baker.

Type.—Catalogue No. 22882, United States National Museum.

Psen (Mimesa) aureohirta sp. nov.

Female.—Length, 8 millimeters. Clypeus convex medially,

surface granular, apical margin truncate with a broad, shallow emargination; face closely punctured, without a transverse carina; frontal carina complete from anterior ocellus to between bases of antennæ and of uniform strength; along the inner margin of eye to level of anterior ocellus is a rounded raised area; vertex and posterior orbits shining; nearly impunctate; intraocellar area convex; ocelli in a little less than an equilateral triangle; postocellar line slightly shorter than the ocellocular line; scape short, the outer margin curved; flagellum long, subclavate apically; the first joint but little shorter than the second and third; pronotum carinate anteriorly, rounded laterally, the anterior surface granular; scutum with distinct, rather close punctures; parapsidal furrows obsolete; scutellum slightly convex, more sparsely punctured than the scutum; mesopleura and metapleura shining, impunctate; episternauli distinct; inclosed area of propodeum with many strong rugæ, a triangular median area which connects with the carina of the posterior surface; sides and posterior surface of propodeum feebly, widely reticulate; legs rather stout; abdomen shining; petiole cylindrical, curved, as long as posterior leg to middle of femur; pygidial area broad, rounded apically, with large punctures; second cubital cell nearly rectangular; third transverse cubitus strongly bent near middle; second transverse cubitus and second recurrent interstitial. Black; mandibles, scape, flagellum beneath, trochanters, femora beneath basally, tibiæ basally and basitarsi of posterior legs, apical margin of first and two spots on second tergites ferruginous; face, clypeus, posterior orbits, and anterior surface of pronotum dorsally (both latter areas more sparsely) with appressed golden pubescence; thorax with sparse golden pubescence. Wings yellowish hyaline; venation dark brown.

Male.—Length, 7 millimeters; length of antennæ, 4 millimeters. Flagellum joints 5 to 9, inclusive, apically spinose beneath; apical margins of tergites 3 and 4 each with four long, curved spines; pygidial area obsolete; wings hyaline. Agrees otherwise with female.

Paratype indicates that the second recurrent may be received at base of third cubital cell.

Type locality.—Mount Maquiling, Laguna, Luzon. Described from two females (one type) and one male (allotype) from Mount Maquiling, and one male paratype from Los Baños. All from C. F. Baker.

Type.—Catalogue No. 22883, United States National Museum.